3.5 Fish

This assessment focuses primarily on fish species that are listed or candidates for listing under the ESA and California Endangered Species Act (CESA). The species include Central Valley fall-/late fall–run Chinook salmon (ESA, candidate), Sacramento River winter-run Chinook salmon (ESA and CESA, endangered), Central Valley spring-run Chinook salmon (ESA and CESA, threatened), southern Oregon/northern California coasts coho salmon (ESA and CESA, threatened), Central Valley steelhead (ESA, threatened), delta smelt (ESA and CESA, threatened), splittail (ESA, listing determination remanded), and striped bass (an important sport fish). The response of the selected species to the Proposed Action is an indicator of the potential response by other species. The full range of environmental conditions and fish habitat elements potentially affected is encompassed by the assessment for the species specifically discussed.

3.5.1 Affected Environment

Central Valley fall-/late fall–run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, delta smelt, and splittail are native species that occur in streams of the Central Valley and the Delta. Striped bass is an abundant nonnative fish that occurs in the Central Valley and the Delta. Southern Oregon/northern California coasts coho salmon occurs in the Trinity River. The coho salmon is included in the impact analysis because operation of the SWP and CVP in response to changes in Delta operations has the potential to affect Trinity River flows. Table 3.5-1 lists some of the native and nonnative fishes that occur in Central Valley waters.

Detailed information on the life histories of Chinook salmon, steelhead, coho salmon, delta smelt, splittail, striped bass, and other species is located in Appendix F, “Supplemental Fish Information.” This appendix also includes a detailed discussion of factors that affect abundance of fish species, including spawning habitat area, rearing habitat area, migration habitat conditions, water temperature, entrainment, contaminants, predation, and food.

3.5.2 Approach

Methodology

The assessment of effects considers the occurrence and potential occurrence of species and species’ life stages relative to the magnitude, timing, frequency, and duration of environmental conditions that result from changes in water supply operations. The assessment links project actions to changes in environmental correlates (environmental conditions or suites of environmental conditions that individually or synergistically affect the survival, growth, fecundity, and movement of a species). Environmental correlates addressed in this assessment include spawning habitat quantity, rearing habitat quantity, migration habitat condition, water temperature, food, and entrainment in diversions (Table 3.5-2).

Please refer to Appendix F, "Supplemental Fish Information," for a detailed discussion of the assessment approach and methods that were used in this analysis.

The following discussion of potential fish impacts identifies changes attributable to implementing the Proposed Action under the simulated 2001 and 2020 levels of development. This is accomplished by comparing model results for the 2001 LOD with the Proposed Action (i.e., Proposed Action) and the 2001 LOD without the Proposed Action (i.e., Existing Condition), as well as comparing model results for the 2020 LOD with the Proposed Action (i.e., Proposed Action) and the 2020 LOD without the Proposed Action (i.e., No Action).

Significance Criteria

Assessment species are selected based on listing under the ESA, listing in environmental management plans (e.g., local environmental plans and State resource agency plans), and ecological, economic, or social importance. Under NEPA and CEQA, impacts are considered significant when project actions, viewed with past, current, and reasonably foreseeable future projects, potentially reduce the abundance and distribution of the assessed fish species (Public Resources Code Section 21083; Guidelines Section 15065). Significant impacts may occur through substantial:

- interference with the movement of any resident or migratory fish species;
- long- or short-term loss of habitat quality or quantity;
- adverse effects on rare or endangered species or habitat of the species; or
- adverse effects on fish communities or species protected by applicable environmental plans and goals.

To be determined significant, an impact would likely result in reduction of species population abundance and distribution. Change in survival, growth, reproduction, and movement for any given life stage, however, may not affect the abundance and distribution of a species. Quantifying population level effects is complicated by annual variation in species abundance and distribution in response to variable environmental conditions that may or may not be driven by human activities. In addition, beneficial effects may offset adverse effects for specific aspects of specific life stages, resulting in beneficial or minimal impacts on the overall population.

The significance thresholds under NEPA and CEQA for species population abundance and distribution require maintenance of population resilience and

Table 3.5-1. Central Valley Species Potentially Affected by the Proposed Action

Common Name—Origin	Scientific Name	Distribution
Lamprey (2 species)—native	*Lampetra* spp.	Central Valley rivers; Delta; San Francisco Bay estuary
Chinook salmon (winter-, spring-, fall-, and late fall–runs)—native	*Oncorhynchus tshawytscha*	Central Valley rivers; Delta; San Francisco Bay estuary
Chum salmon—rare	*Oncorhynchus keta*	Central Valley rivers; Delta and San Francisco Bay estuary
Kokanee—nonnative	*Oncorhynchus nerka*	Central Valley reservoirs
Steelhead/rainbow trout—native	*Oncorhynchus mykiss*	Central Valley rivers; Delta and San Francisco Bay estuary
Brown trout—nonnative	*Salmo trutta*	Central Valley reservoirs
White sturgeon—native	*Acipenser transmontanus*	Central Valley rivers; Delta; San Francisco Bay estuary
Green sturgeon—native	*Acipenser medirostris*	Central Valley rivers; Delta; San Francisco Bay estuary
Longfin smelt—native	*Spirinchus thaleichthys*	Delta and San Francisco Bay estuary
Delta smelt—native	*Hypomesus transpacificus*	Delta and San Francisco Bay estuary
Wakasagi—nonnative	*Hypomesus nipponensis*	Central Valley rivers and reservoirs; Delta
Sacramento sucker—native	*Catostomus occidentalis*	Central Valley rivers; Delta
Sacramento pikeminnow—native	*Ptychocheilus grandis*	Central Valley rivers; Delta
Splittail—native	*Pogonichthys macrolepidotus*	Central Valley rivers; Delta and San Francisco Bay estuary
Sacramento blackfish—native	*Orthodon microlepidotus*	Central Valley rivers; Delta
Hardhead—native	*Mylopharodon conocephalus*	Central Valley rivers; Delta
Speckled dace	*Rhinichthys osculus*	Sacramento River and tributaries
California roach	*Lavinia symmetricus*	Central Valley Rivers
Hitch—native	*Lavina exilicauda*	Central Valley rivers; Delta
Golden shiner—nonnative	*Notemigonus crysoleucas*	Central Valley rivers and reservoirs; Delta
Fathead minnow—nonnative	*Pimephales promelas*	Central Valley rivers and reservoirs; Delta
Goldfish—nonnative	*Carassius auratus*	Central Valley rivers and reservoirs; Delta
Carp—nonnative	*Cyprinus carpio*	Central Valley rivers and reservoirs; Delta
Threadfin shad—nonnative	*Dorosoma petenense*	Central Valley rivers and reservoirs; Delta
American shad—nonnative	*Alosa sapidissima*	Central Valley rivers; Delta; San Francisco Bay estuary
Black bullhead—nonnative	*Ictalurus melas*	Central Valley rivers and reservoirs; Delta
Brown bullhead—nonnative	*Ictalurus nebulosus*	Central Valley rivers and reservoirs; Delta
White catfish—nonnative	*Ictalurus catus*	Central Valley rivers; Delta

Table 3.5-1. Continued

Common Name—Origin	Scientific Name	Distribution
Channel catfish—nonnative	*Ictalurus punctatus*	Central Valley rivers and reservoirs; Delta
Mosquitofish—nonnative	*Gambusia affinis*	Central Valley rivers and reservoirs; Delta
Inland silverside—nonnative	*Menidia audena*	Central Valley rivers; Delta
Threespine stickleback—native	*Gasterosteus aculaetus*	Central Valley rivers; Delta; San Francisco Bay estuary
Striped bass—nonnative	*Morone saxatilis*	Central Valley rivers and reservoirs; Delta; San Francisco Bay estuary
Bluegill—nonnative	*Lepomis macrochirus*	Central Valley rivers and reservoirs; Delta
Green sunfish—nonnative	*Lepomis cyanellus*	Central Valley rivers and reservoirs; Delta
Redear sunfish—nonnative	*Lepomis microlophus*	Central Valley rivers and reservoirs; Delta
Warmouth—nonnative	*Lepomis gulosus*	Central Valley rivers and reservoirs; Delta
White crappie—nonnative	*Pomoxis annularis*	Central Valley rivers and reservoirs; Delta
Black crappie—nonnative	*Pomoxis nigromaculatus*	Central Valley rivers and reservoirs; Delta
Largemouth bass—nonnative	*Micropterus salmoides*	Central Valley rivers and reservoirs; Delta
Redeye Bass	*Micropterus coosae*	Central Valley rivers and reservoirs
Spotted bass—nonnative	*Micropterus punctulatus*	Central Valley rivers and reservoirs; Delta
Smallmouth bass—nonnative	*Micropterus dolomieui*	Central Valley rivers and reservoirs; Delta
Bigscale logperch—nonnative	*Percina macrolepida*	Central Valley rivers; Delta
Yellowfin goby—nonnative	*Acanthogobius flavimanus*	Delta and San Francisco Bay estuary
Chameleon goby—nonnative	*Tridentiger trigonocephalus*	Delta and San Francisco Bay estuary
Prickly sculpin—native	*Cottus asper*	Central Valley rivers
Rainwater killfish – nonnative	*Lucania parva*	Central Valley rivers, Delta
Yellow bullhead – nonnative	*Ameriurus natalis*	Central Valley rivers, Delta
Longjaw mudsucker – native	*Gillichthys mirabilis*	Delta, Bay estuary
Shimofuri Goby – nonnative	*Tridentiger bafasciatus*	Delta, Bay estuary
Pacific Lamprey - native	*Lampetra tridentate*	Central Valley rivers, Delta, Bay estuary
Tule perch—native	*Hysterocarpus traskii*	Central Valley rivers; Delta

Table 3.5-2. Summary of Assessment Models and Tools by Environmental Correlate for Each Fish Species and Life Stage

Assessed Environmental Correlate	Simulated Environmental Condition	Models Used to Simulate Environmental Conditions	Analytical Tool	Species: Life Stage
Spawning Habitat Quantity	River Flow—Trinity River	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effects	Coho Salmon: spawning and incubation
	River Flow—Sacramento River at Keswick Dam, Colusa, and Verona	CALSIM II, Water years 1922–1994	Flow-habitat relationship for salmon and steelhead; high flow assessment of floodplain inundation for splittail	Winter-run Chinook Salmon: spawning and incubation Spring-run Chinook Salmon: spawning and incubation Fall-run Chinook Salmon: spawning and incubation Late Fall–run Chinook Salmon: spawning and incubation Steelhead: spawning and incubation Splittail: spawning and incubation
	River Flow—Feather River	CALSIM II, Water years 1922–1994	Flow-habitat relationship	Spring-run Chinook Salmon: spawning and incubation Fall-run Chinook Salmon: spawning and incubation Steelhead: spawning and incubation
	River Flow—American River	CALSIM II, Water years 1922–1994	Flow-habitat relationship	Fall-run Chinook Salmon: spawning and incubation Steelhead: spawning and incubation
	River Flow—San Joaquin	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effect	Fall-run Chinook Salmon: spawning and incubation Steelhead: spawning and incubation
	Delta Outflow (and X2)	CALSIM II, Water years 1922–1994	Qualitative assessment of change in freshwater area in the Delta	Delta Smelt: spawning Striped Bass: spawning

Assessed Environmental Correlate	Simulated Environmental Condition	Models Used to Simulate Environmental Conditions	Analytical Tool	Species: Life Stage
	Reservoir Storage—Clair Engle, Shasta, Oroville, and Folsom	CALSIM II, Water years 1922–1994	Qualitative assessment of changes in reservoir storage effects	Reservoir species: spawning and incubation
Rearing Habitat Quantity	River Flow—Trinity River	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effects	Coho Salmon: juvenile
	River Flow—Sacramento River at Keswick Dam, Colusa, and Verona	CALSIM II, Water years 1922–1994	Low flow assessment based on flow-habitat relationship for salmon and steelhead; high flow assessment based on floodplain inundation for salmon and splittail	Winter-run Chinook Salmon: juvenile Spring-run Chinook Salmon: juvenile Fall-run Chinook Salmon: juvenile Late Fall–run Chinook Salmon: juvenile Steelhead: juvenile Splittail: juvenile
	River Flow—Feather River	CALSIM II, Water years 1922–1994	Low flow assessment based on flow-habitat relationship	Spring-run Chinook Salmon: juvenile Fall-run Chinook Salmon: juvenile Steelhead: juvenile
	River Flow—American River	CALSIM II, Water years 1922–1994	Low flow assessment based on flow-habitat relationship	Fall-run Chinook Salmon: juvenile Steelhead: juvenile
	River Flow—San Joaquin	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effects	Fall-run Chinook Salmon: juvenile Steelhead: juvenile
	Delta Outflow (and X2)	CALSIM II, Water years 1922–1994	Change in rearing habitat area based on location of X2	Delta Smelt: juvenile and adult Striped Bass: juvenile
	Reservoir Storage—Clair Engle, Shasta, Oroville, and Folsom	CALSIM II, Water years 1922–1994	Qualitative assessment of reservoir storage effects	reservoir species: juvenile

Assessed Environmental Correlate	Simulated Environmental Condition	Models Used to Simulate Environmental Conditions	Analytical Tool	Species: Life Stage
Migration Habitat Conditions	River Flow—Sacramento River	CALSIM II, Water years 1922–1994	Assessment of floodplain inundation for splittail; assessment of low flow effects for striped bass	Splittail: adult Striped Bass: egg and larvae
	Delta Channel Flows—Sacramento River, Delta Cross Channel, and Georgiana Slough	CALSIM II, Water years 1922–1994	Pathway-survival relationship for chinook salmon and steelhead	Winter-run Chinook Salmon: juvenile Spring-run Chinook Salmon: juvenile Fall-run Chinook Salmon: juvenile Late Fall–run Chinook Salmon: juvenile Steelhead: juvenile
	Delta Channel Flows—San Joaquin River and head of Old River	CALSIM II, Water years 1922–1994	Pathway-survival relationship for chinook salmon and steelhead	Fall-run Chinook Salmon: juvenile Steelhead: juvenile
	Delta Channel Flows—South Delta	DWR DSM2	Qualitative assessment based on barrier elevation and tidal flow volume	Fall-run chinook salmon: juvenile Delta Smelt: adult and larvae
	Dissolved Oxygen—San Joaquin River at Stockton	CALSIM II, Water years 1922–1994; DWRDSM2	Qualitative assessment based on flow at Stockton	Fall-run Chinook Salmon: adult Steelhead: adult
Water Temperature	Water Temperature—Trinity River	CALSIM II, Water years 1922–1994; U.S. Bureau of Reclamation Monthly Water Temperature Model	Temperature-survival relationship	Coho Salmon: adult, incubation, juvenile, smolt

Table 3.5-2. Continued

Assessed Environmental Correlate	Simulated Environmental Condition	Models Used to Simulate Environmental Conditions	Analytical Tool	Species: Life Stage
	Water Temperature—Sacramento River at Keswick Dam, Bend Bridge, and Red Bluff Diversion Dam	CALSIM II, Water years 1922–1994; U.S. Bureau of Reclamation Monthly Water Temperature Model	Temperature-survival relationship	Winter-run Chinook Salmon: adult, incubation, juvenile, smolt Spring-run Chinook Salmon: adult, incubation, juvenile, smolt Fall-run Chinook Salmon: adult, incubation, juvenile, smolt Late Fall–run Chinook Salmon: adult, incubation, juvenile, smolt Steelhead: adult, incubation, juvenile, smolt
	Water Temperature—Feather River	CALSIM II, Water years 1922–1994; U.S. Bureau of Reclamation Monthly Water Temperature Model	Temperature-survival relationship	Spring-run Chinook Salmon: adult, incubation, juvenile, smolt Fall-run Chinook Salmon: adult, incubation, juvenile, smolt Steelhead: adult, incubation, juvenile, smolt
	Water Temperature—American River	CALSIM II, Water years 1922–1994; U.S. Bureau of Reclamation Monthly Water Temperature Model	Temperature-survival relationship	Fall-run Chinook Salmon: adult, incubation, juvenile, smolt Steelhead: adult, incubation, juvenile, smolt
	River Flow—San Joaquin	CALSIM II, Water years 1922–1994	Qualitative assessment of potential water temperature effects	Fall-run Chinook Salmon: adult, incubation, juvenile, smolt Steelhead: adult, incubation, juvenile, smolt
Food	River Flow—Trinity River	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effect	Coho Salmon: rearing

Assessed Environmental Correlate	Simulated Environmental Condition	Models Used to Simulate Environmental Conditions	Analytical Tool	Species: Life Stage
	River Flow—Sacramento River at Keswick Dam, Colusa, and Verona	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effect; high flow assessment of floodplain inundation	Winter-run Chinook Salmon: rearing Spring-run Chinook Salmon: rearing Fall-run Chinook Salmon: rearing Late Fall–run Chinook Salmon: rearing Steelhead: in-river rearing Splittail: rearing
	River Flow—Feather River	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effect	Spring-run Chinook Salmon: rearing Fall-run Chinook Salmon: rearing Steelhead: rearing
	River Flow—American River	CALSIM II, Water years 1922–1994	Qualitative assessment of flow effect	Fall-run Chinook Salmon: rearing Steelhead: rearing
	River Flow—San Joaquin	CALSIM, Water years 1922–1994	Qualitative assessment of flow effect	Fall-run Chinook Salmon: rearing Steelhead: rearing
	Delta Outflow (and X2)	CALSIM, Water years 1922–1994	Qualitative assessment of change X2 location	Delta Smelt: rearing Striped Bass: rearing
Entrainment in Delta diversions	SWP and CVP Exports; particle transport	CALSIM, Water years 1922–1994; DWRDSM2; Particle Tracking Model (DSM2-PTM)	Export volume-entrainment loss relationships; particle transport-entrainment loss relationships for passive and active fish behavior	Winter-run Chinook Salmon: juvenile Spring-run Chinook Salmon: juvenile Fall-run Chinook Salmon (from Sacramento, Mokelumne, and San Joaquin Rivers): juvenile Late Fall–run Chinook Salmon: juvenile Steelhead: juvenile Delta Smelt: adult, larvae, juvenile Splittail: juvenile Striped Bass: egg, larvae, juvenile

persistence. Resilience is the ability of the species to increase in abundance and distribution in response to improved environmental conditions. Persistence is the ability of the species to sustain itself through periods of adverse environmental conditions. The thresholds include:

- any permanent change in an environmental correlate that would substantially reduce the average abundance of the population over a range of weather-related conditions (e.g., water year types);
- any change in an environmental correlate that would permanently limit the geographic range and the seasonal timing of any life stage; and
- any potential reduction in abundance for years with deficient environmental conditions (e.g., water years 1987–1991 or years when weather-related conditions fall below the lowest 20th percentile).

3.5.3 Environmental Consequences

Existing Condition (2001 LOD)

Existing Condition (i.e., 2001 LOD without the Proposed Action) does not include any changes to water supply operations. Upstream reservoir operations, diversions, and SWP and CVP pumping from the Delta continue. Effects of flow and diversions on fish habitat conditions in the Trinity, Sacramento, Feather, American, and San Joaquin Rivers and the Delta remain the same as under existing water supply operations criteria. Effects of reservoir storage on fish habitat in Trinity, Shasta, Oroville, and Folsom Reservoirs also remain the same as under existing water supply operations criteria.

No Action Alternative (2020 LOD)

The No Action Alternative represents the 2020 LOD. The simulation of hydrology for the No Action Alternative results (i.e., without the Proposed Action) is compared to the simulated Existing Condition.

Compared to simulated Existing Condition, the No Action Alternative would result in minimal change to CVP and SWP operations and little change in effects on fish.

Proposed Action Alternative

Conditions under the Proposed Action Alternative are compared to simulated Existing Condition and simulated No Action conditions. Water supply operations under the Proposed Action would increase Delta pumping, changing CVP and SWP diversions and operation of CVP and SWP reservoirs (Section

3.2, Water Supply) compared to operations under the simulated Existing Condition and No Action. Changes in flow and diversions may affect fish and fish habitat in reaches of the Trinity, Sacramento, Feather, American, and San Joaquin Rivers and in the Delta and Suisun Bay. Simulated flow, SWP and CVP pumping, and water temperature conditions are evaluated. Environmental conditions potentially affected with implementation of the Proposed Action Alternative are summarized in Table 3.5-3.

Chinook Salmon

The following assessment identifies potential operations-related impacts of implementing the Proposed Action on winter-, spring-, and fall-/late fall–run Chinook salmon in Central Valley rivers and the Delta. Environmental correlates addressed for Chinook salmon include spawning habitat quantity, rearing habitat quantity, migration habitat condition, water temperature, food, and entrainment in diversions. The changes in environmental conditions created by the Proposed Action would have less-than-significant impacts on Chinook salmon because population and distribution would not be reduced by the construction, operation, and maintenance of the Intertie facilities.

Impact Fish-1: Operations-Related Change in Spawning Habitat Area for Chinook Salmon

Modeled Existing Condition (2001 LOD) Comparison

Fall-/late fall–run Chinook salmon spawn in the cool reaches of the Sacramento, Feather, and American Rivers; in tributaries of the San Joaquin River downstream of terminal reservoirs; and in the Trinity River. The simulated flow volume for 1922–1994 for the San Joaquin River and its tributaries under the Proposed Action is nearly identical to the simulated flow under Existing Condition (Figure 3.5-1). (Note: Figure 3.5-1 and several others in this chapter plot flows for each individual month during the simulation period. For each month, flow under the simulated Existing Condition is plotted against the X [horizontal] axis and the flow under the Proposed Action is plotted against the Y [vertical] axis. Thus, flows identical under each alternative fall along a 45-degree diagonal line. Flows that are lower under the simulated Existing Condition than under the Proposed Action fall below the line, and flows that are higher fall above the line.) Given that flow conditions are unchanged for the Proposed Action, effects of flow and water temperature conditions on fish and fish habitat in the San Joaquin River are not considered further. Similarly, flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated Existing Condition, with increased flow in a few months (Figure 3.5-1). There is no change in spawning habitat area.

The spawning and egg incubation period for fall-/late fall–run Chinook salmon extends from October through May in the Sacramento River and October through February in the Feather and American Rivers. Winter-run Chinook salmon spawn in the Sacramento River, generally above Red Bluff Diversion Dam

Table 3.5-3. Potential Actions, Impact Mechanisms, and Affected Environmental Conditions with implementation of the Proposed Action

Project Actions	Impact Mechanisms Associated with Implementing Project Actions	Affected Environmental Conditions
Increase Central Valley Project and State Water Project Delta pumping	■ Change in upstream reservoir operations ■ Change in Delta exports	■ Reservoir shallow water area: operations may change the seasonal stage of reservoirs ■ Flow stage: river stage could change in response to changes in reservoir releases ■ Depth: river depth would change with stage ■ Flow velocity: river velocity would change with river stage; net Delta channel velocity could respond to river inflow changes and export changes ■ Net flow direction: change in net Delta channel flow direction would respond to river inflow changes and export changes ■ Floodplain inundation: dependent on change in river stage ■ Diversion: Delta exports would increase in response to changes in Delta operations and upstream reservoir operations; upstream diversions may also change ■ Substrate: could be affected depending on the magnitude of river flow change related to controlled or uncontrolled releases from reservoirs during storm events ■ Cover: could be affected depending on the magnitude, duration, timing, and frequency of change in river stage and effects on riparian vegetation ■ Water temperature: operations may affect reservoir storage volume and river flow, subsequently affecting river water temperature ■ Salinity: dependent on changes in Delta outflow in response to Delta inflow and exports ■ Outside food input: could be affected depending on the magnitude of river flow change ■ Food production: dependent on change in residence time, salinity distribution, nutrient input, and losses to diversion

(RBDD), and spring-run Chinook salmon spawn in the cool reaches of the Sacramento and Feather Rivers. The spawning and egg incubation period for winter-run Chinook salmon extends from April through September. The spawning and egg incubation period for spring-run Chinook salmon extends from August through December.

Changes in water supply operations potentially affect flow and spawning habitat area for Chinook salmon in the Sacramento, Feather, and American Rivers (Figure 3.5-2). Flows simulated for Existing Condition provide near the maximum spawning habitat area during the months of spawning for winter-, spring-, fall-, and late fall–run Chinook salmon in the Sacramento, Feather, and American Rivers (Table 3.5-4). Changes in Sacramento River flow attributable to the Proposed Action would not affect spawning habitat area for any run in the Sacramento and Feather Rivers (Table 3.5-5). In the American River, spawning habitat area for fall-run Chinook salmon is not affected during most months (Table 3.5-5) but overall is slightly more abundant in a few months because of slightly higher flows. The slight increase in spawning habitat area would not be expected to affect adult spawning success and survival of fall-run Chinook salmon eggs and larvae in the American River. This impact is considered less than significant. No mitigation is required.

No Action Alternative

The simulated flow volume for 1922–1994 for the San Joaquin River and its tributaries and for the Trinity River under the Proposed Action is nearly identical to the simulated flow under No Action (Figure 3.5-3). There is no change in spawning habitat area.

Changes in water supply operations potentially affect flow and spawning habitat area for Chinook salmon in the Sacramento, Feather, and American Rivers (Figure 3.5-4). Flows simulated for No Action provide near the maximum spawning habitat area during the months of spawning for winter-, spring-, fall-, and late fall–run Chinook salmon in the Sacramento, Feather, and American Rivers (Table 3.5-6). Changes in Sacramento River flow attributable to the Proposed Action would not affect spawning habitat area for any run in the Sacramento and Feather Rivers (Table 3.5-7). In the American River, spawning habitat area for fall-run Chinook salmon is not affected during most months (Table 3.5-7). As described above for the Existing Condition, this impact is less than significant. No mitigation is required.

Impact Fish-2: Operations-Related Loss of Rearing Habitat Area for Chinook Salmon

Modeled Existing Condition (2001 LOD) Comparison

Changes in water supply operations potentially affect flow and rearing habitat area for Chinook salmon in the Sacramento, Feather, and American Rivers (Figure 3.5-2). As noted previously, flows in the San Joaquin and Trinity Rivers are unchanged relative to simulated Existing Condition, and rearing habitat is not affected (Figure 3.5-1).

Fall-run Chinook salmon rear in the Sacramento, Feather, and American Rivers from January through May. Winter-run Chinook salmon rear in the Sacramento River upstream and downstream of RBDD, and spring-run Chinook salmon rear in the cool reaches of the Sacramento and Feather Rivers. The rearing period for winter-run Chinook salmon can extend from July through April. The rearing period for spring-run Chinook salmon extends through all months of the year, although most rearing occurs from November through May. Some late fall–run Chinook salmon rear in the Sacramento River from March through November, with most rearing from April through November.

The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action varies relative to flow under the simulated Existing Condition (Figure 3.5-2). The reduction in flow in some months and increases in other months and years have minimal effect on the range of flows that could affect rearing habitat area (Table 3.5-8). The impact on Chinook salmon of any run would be less than significant. No mitigation is required because population and distribution would not be reduced by the construction, operation, and maintenance of the Proposed Action.

Inundated floodplain habitat in the Yolo and Sutter Bypasses provides important rearing habitat for juvenile Chinook salmon (Sommer et al. 2001; Sommer et al. 2000). Changes in water supply operations could affect reservoir storage and therefore the frequency of floodplain inundation. The small changes in river flows under the Proposed Action do not affect higher volume flows Figure 3.5-2). The frequency and duration of floodplain inundation would be similar for existing conditions and the Proposed Action because of the relatively small increase in CVP exports and net CVP/SWP exports.

Modeled No Action (2020 LOD) Comparison

As noted previously, flows in the San Joaquin and Trinity Rivers are unchanged relative to the simulated No Action condition, and rearing habitat is not affected (Figure 3.5-3). The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action varies relative to flow under the simulated No Action condition (Figure 3.5-4). The reduction in flow in some months and increases in other months and years have minimal effect on the range of flows that could affect rearing habitat area (Table 3.5-9). As described above for the Existing Condition, the impact on Chinook salmon of any run would be less than significant. No mitigation is required.

The small changes in river flows under the Proposed Action do not affect higher volume flows (Figure 3.5-4) and the frequency and duration of floodplain inundation would be similar for the simulated No Action condition and the Proposed Action.

Table 3.5-4. Frequency of Spawning Habitat Availability for Chinook Salmon and Steelhead in the Sacramento, Feather and American Rivers for the Existing Condition (2001 LOD), 1922–1994 Simulation.

Sacramento River at Keswick						Feather River Below Thermalito				American River at Nimbus		
	Spawning						Spawning				Spawning	
Proportion of Spawning Habitat Available (%)	Fall-Run Chinook Salmon	Late Fall–Run Chinook Salmon	Winter-run Chinook salmon	Spring-run Chinook salmon	Steel-head	Proportion of Spawning Habitat Available (%)	Fall-Run Chinook Salmon	Spring-run Chinook salmon	Steel-head	Proportion of Spawning Habitat Available (%)	Fall-Run Chinook Salmon	Steel-head
<+100%	219	219	292	219	365	<+100%	219	219	365	<+100%	153	302
<+90%	0	0	0	0	0	<+90%	0	0	0	<+90%	10	20
<+80%	0	0	0	0	0	<+80%	0	0	0	<+80%	7	4
<+70%	0	0	0	0	0	<+70%	0	0	0	<+70%	27	20
<+60%	0	0	0	0	0	<+60%	0	0	0	<+60%	0	0
<+50%	0	0	0	0	0	<+50%	0	0	0	<+50%	13	15
<+40%	0	0	0	0	0	<+40%	0	0	0	<+40%	8	0
<+30%	0	0	0	0	0	<+30%	0	0	0	<+30%	1	4
<+20%	0	0	0	0	0	<+20%	0	0	0	<+20%	0	0
<+10%	0	0	0	0	0	<+10%	0	0	0	<+10%	0	0
0%	0	0	0	0	0	0%	0	0	0	0%	0	0

Table 3.5-5. Frequency of Change, Relative to Existing Condition (2001 LOD), in Spawning Habitat Availability for Chinook Salmon and Steelhead in the Sacramento, Feather, and American Rivers for the Proposed Action, 1922–1994 Simulation

Sacramento River at Keswick						Feather River Below Thermolito				American River at Nimbus		
	Spawning						Spawning				Spawning	
Change in Percentage Area	Fall-Run Chinook Salmon	Late-Fall Run Chinook Salmon	Winter-run Chinook salmon	Spring-run Chinook salmon	Steel-head	Change in Percentage Area	Fall-Run Chinook Salmon	Spring-run Chinook salmon	Steel-head	Change in Percentage Area	Fall-Run Chinook Salmon	Steel-head
<+100%	0	0	0	0	0	<+100%	0	0	0	<+100%	0	0
<+90%	0	0	0	0	0	<+90%	0	0	0	<+90%	0	0
<+80%	0	0	0	0	0	<+80%	0	0	0	<+80%	0	0
<+70%	0	0	0	0	0	<+70%	0	0	0	<+70%	0	0
<+60%	0	0	0	0	0	<+60%	0	0	0	<+60%	0	0
<+50%	0	0	0	0	0	<+50%	0	0	0	<+50%	0	0
<+40%	0	0	0	0	0	<+40%	0	0	0	<+40%	2	0
<+30%	0	0	0	0	0	<+30%	0	0	0	<+30%	1	2
<+20%	0	0	0	0	0	<+20%	0	0	0	<+20%	2	2
<+10%	0	0	0	0	0	<+10%	0	0	0	<+10%	1	5
0%	219	219	292	219	365	0%	219	219	365	0%	209	353
>-10%	0	0	0	0	0	>-10%	0	0	0	>-10%	4	2
>-20%	0	0	0	0	0	>-20%	0	0	0	>-20%	0	0
>-30%	0	0	0	0	0	>-30%	0	0	0	>-30%	0	0
>-40%	0	0	0	0	0	>-40%	0	0	0	>-40%	0	1
>-50%	0	0	0	0	0	>-50%	0	0	0	>-50%	0	0
>-60%	0	0	0	0	0	>-60%	0	0	0	>-60%	0	0
>-70%	0	0	0	0	0	>-70%	0	0	0	>-70%	0	0
>-80%	0	0	0	0	0	>-80%	0	0	0	>-80%	0	0
>-90%	0	0	0	0	0	>-90%	0	0	0	>-90%	0	0
>=-100%	0	0	0	0	0	>=-100%	0	0	0	>=-100%	0	0

Table 3.5-6. Frequency of Spawning Habitat Availability for Chinook Salmon and Steelhead in the Sacramento, Feather and American Rivers for No Action (2020 LOD), 1922–1994 Simulation.

Sacramento River at Keswick						Feather River Below Thermalito				American River at Nimbus		
	Spawning						Spawning				Spawning	
Proportion of Spawning Habitat Available (%)	Fall-Run Chinook Salmon	Late Fall–Run Chinook Salmon	Winter-run Chinook salmon	Spring-run Chinook salmon	Steel-head	Proportion of Spawning Habitat Available (%)	Fall-Run Chinook Salmon	Spring-run Chinook salmon	Steel-head	Proportion of Spawning Habitat Available (%)	Fall-Run Chinook Salmon	Steel-head
<+100%	219	219	292	219	365	<+100%	219	219	365	<+100%	142	287
<+90%	0	0	0	0	0	<+90%	0	0	0	<+90%	16	31
<+80%	0	0	0	0	0	<+80%	0	0	0	<+80%	2	1
<+70%	0	0	0	0	0	<+70%	0	0	0	<+70%	31	22
<+60%	0	0	0	0	0	<+60%	0	0	0	<+60%	0	0
<+50%	0	0	0	0	0	<+50%	0	0	0	<+50%	16	17
<+40%	0	0	0	0	0	<+40%	0	0	0	<+40%	6	0
<+30%	0	0	0	0	0	<+30%	0	0	0	<+30%	6	7
<+20%	0	0	0	0	0	<+20%	0	0	0	<+20%	0	0
<+10%	0	0	0	0	0	<+10%	0	0	0	<+10%	0	0
0%	0	0	0	0	0	0%	0	0	0	0%	0	0

Table 3.5-7. Frequency of Change, Relative to the No Action (2020 LOD), in Spawning Habitat Availability for Chinook Salmon and Steelhead in the Sacramento, Feather, and American Rivers for the Proposed Action, 1922–1994 Simulation

Sacramento River at Keswick						Feather River Below Thermolito				American River at Nimbus		
	Spawning						Spawning				Spawning	
Change in Percentage Area	Fall-Run Chinook Salmon	Late-Fall Run Chinook Salmon	Winter-run Chinook salmon	Spring-run Chinook salmon	Steel-head	Change in Percentage Area	Fall-Run Chinook Salmon	Spring-run Chinook salmon	Steel-head	Change in Percentage Area	Fall-Run Chinook Salmon	Steel-head
<+100%	0	0	0	0	0	<+100%	0	0	0	<+100%	0	0
<+90%	0	0	0	0	0	<+90%	0	0	0	<+90%	0	0
<+80%	0	0	0	0	0	<+80%	0	0	0	<+80%	0	0
<+70%	0	0	0	0	0	<+70%	0	0	0	<+70%	0	0
<+60%	0	0	0	0	0	<+60%	0	0	0	<+60%	0	0
<+50%	0	0	0	0	0	<+50%	0	0	0	<+50%	0	0
<+40%	0	0	0	0	0	<+40%	0	0	0	<+40%	0	0
<+30%	0	0	0	0	0	<+30%	0	0	0	<+30%	0	0
<+20%	0	0	0	0	0	<+20%	0	0	0	<+20%	0	0
<+10%	0	0	0	0	0	<+10%	0	0	1	<+10%	0	3
0%	219	219	292	219	365	0%	219	219	364	0%	218	361
>-10%	0	0	0	0	0	>-10%	0	0	0	>-10%	0	1
>-20%	0	0	0	0	0	>-20%	0	0	0	>-20%	0	0
>-30%	0	0	0	0	0	>-30%	0	0	0	>-30%	1	0
>-40%	0	0	0	0	0	>-40%	0	0	0	>-40%	0	0
>-50%	0	0	0	0	0	>-50%	0	0	0	>-50%	0	0
>-60%	0	0	0	0	0	>-60%	0	0	0	>-60%	0	0
>-70%	0	0	0	0	0	>-70%	0	0	0	>-70%	0	0
>-80%	0	0	0	0	0	>-80%	0	0	0	>-80%	0	0
>-90%	0	0	0	0	0	>-90%	0	0	0	>-90%	0	0
>=-100%	0	0	0	0	0	>=-100%	0	0	0	>=-100%	0	0

Table 3.5-8. Frequency of Occurrence of the Percentage Change in Flow from Existing Condition (2001 LOD) That Could Affect Rearing Habitat Area for Chinook Salmon and Steelhead in the Sacramento, Feather, and American Rivers for Proposed Action, 1922–1994 Simulation

Sacramento River at Keswick						Feather River Below Thermalito				American River at Nimbus		
	Rearing						Rearing				Rearing	
Percentage Change in Flow	Fall-Run Chinook Salmon	Late Fall–Run Chinook Salmon	Winter-run Chinook salmon	Spring-run Chinook salmon	Steel-head	Percentage Change in Flow	Fall-Run Chinook Salmon	Spring-run Chinook salmon	Steel-head	Percentage Change in Flow	Fall-Run Chinook Salmon	Steel-head
<+100%	0	0	0	0	0	<+100%	0	0	0	<+100%	0	1
<+90%	0	0	0	0	0	<+90%	0	0	0	<+90%	0	1
<+80%	0	0	0	0	0	<+80%	0	0	0	<+80%	0	0
<+70%	0	0	0	0	0	<+70%	0	1	1	<+70%	0	0
<+60%	0	0	1	1	1	<+60%	0	0	0	<+60%	0	1
<+50%	0	0	0	0	0	<+50%	0	1	1	<+50%	2	2
<+40%	0	0	0	0	0	<+40%	1	1	1	<+40%	3	3
<+30%	0	0	0	0	0	<+30%	2	2	2	<+30%	2	3
<+20%	1	1	2	1	2	<+20%	5	9	17	<+20%	1	3
<+10%	0	0	0	0	0	<+10%	0	0	0	<+10%	0	0
0%	434	582	723	505	869	0%	426	490	834	0%	428	854
>-10%	0	0	0	0	0	>-10%	0	0	0	>-10%	0	0
>-20%	3	1	4	4	4	>-20%	2	3	11	>-20%	1	4
>-30%	0	0	0	0	0	>-30%	1	2	5	>-30%	0	2
>-40%	0	0	0	0	0	>-40%	1	1	3	>-40%	0	1
>-50%	0	0	0	0	0	>-50%	0	0	0	>-50%	0	0
>-60%	0	0	0	0	0	>-60%	0	0	0	>-60%	1	1
>-70%	0	0	0	0	0	>-70%	0	0	0	>-70%	0	0
>-80%	0	0	0	0	0	>-80%	0	0	0	>-80%	0	0
>-90%	0	0	0	0	0	>-90%	0	0	0	>-90%	0	0
>=-100%	0	0	0	0	0	>=-100%	0	0	0	>=-100%	0	0

Table 3.5-9. Frequency of Occurrence of the Percentage Change in Flow from the No Action (2020 LOD) That Could Affect Rearing Habitat Area for Chinook Salmon and Steelhead in the Sacramento, Feather, and American Rivers for Proposed Action, 1922–1994 Simulation

Sacramento River at Keswick						Feather River Below Thermalito				American River at Nimbus		
	Rearing						Rearing				Rearing	
Percentage Change in Flow	Fall-Run Chinook Salmon	Late Fall–Run Chinook Salmon	Winter-run Chinook salmon	Spring-run Chinook salmon	Steel-head	Percentage Change in Flow	Fall-Run Chinook Salmon	Spring-run Chinook salmon	Steel-head	Percentage Change in Flow	Fall-Run Chinook Salmon	Steel-head
<+100%	0	0	0	0	0	<+100%	0	0	0	<+100%	0	0
<+90%	0	0	0	0	0	<+90%	0	0	0	<+90%	0	0
<+80%	0	0	0	0	0	<+80%	0	0	0	<+80%	0	0
<+70%	0	0	0	0	0	<+70%	1	1	1	<+70%	0	1
<+60%	0	0	0	0	0	<+60%	0	0	0	<+60%	0	0
<+50%	0	0	0	0	0	<+50%	0	0	1	<+50%	0	0
<+40%	0	0	0	0	0	<+40%	1	1	1	<+40%	0	0
<+30%	0	0	0	0	0	<+30%	0	1	2	<+30%	1	2
<+20%	0	1	3	3	3	<+20%	0	1	1	<+20%	1	2
<+10%	0	0	0	0	0	<+10%	0	0	0	<+10%	0	0
0%	436	580	721	502	867	0%	434	505	864	0%	436	867
>-10%	0	0	0	0	0	>-10%	0	0	0	>-10%	0	0
>-20%	2	2	5	5	5	>-20%	1	1	2	>-20%	0	1
>-30%	0	1	1	1	1	>-30%	0	0	2	>-30%	0	2
>-40%	0	0	0	0	0	>-40%	0	0	0	>-40%	0	1
>-50%	0	0	0	0	0	>-50%	0	0	1	>-50%	0	0
>-60%	0	0	0	0	0	>-60%	0	0	0	>-60%	0	0
>-70%	0	0	0	0	0	>-70%	0	0	0	>-70%	0	0
>-80%	0	0	0	0	0	>-80%	0	0	0	>-80%	0	0
>-90%	0	0	0	0	0	>-90%	0	0	0	>-90%	0	0
>=-100%	0	0	0	0	0	>=-100%	0	0	0	>=-100%	0	0

Impact Fish-3: Operations-Related Decline in Migration Habitat Conditions for Chinook Salmon

Modeled Existing Condition (2001 LOD) Comparison

Rivers provide a migration pathway between freshwater and estuarine habitats for Chinook salmon. Flows that occur in Central Valley rivers and the Trinity River generally support migration of adult and juvenile Chinook salmon and steelhead. Relative to the simulated Existing Condition, the change in flows under the Proposed Action would not be expected to affect migration of adult and juvenile Chinook salmon in Central Valley rivers (Figures 3.5-1 and 3.5-2).

In the Delta, juvenile Chinook salmon survival is lower for fish migrating through the central Delta than for fish continuing down the Sacramento River channel (Brandes and McLain 2001; Newman and Rice 1997). Juvenile spring-, winter-, and late fall–run Chinook salmon begin entering the Delta from upstream habitat in the Sacramento River and its tributaries during late October and November. Downstream movement and migration continue through April or May, with fall-run juveniles joining in from February through June. Few juvenile Chinook salmon move through the Delta from July through September.

Juvenile Chinook salmon are assumed to move along Delta channel pathways in proportion to flow; therefore, an increase in the proportion of flow diverted off the Sacramento River through the DCC and Georgiana Slough would be expected to increase mortality of migrating juvenile Chinook salmon. The primary factors affecting the proportion of flow diverted off of the Sacramento River are Sacramento River flow and DCC gate operations. DCC gate operations are the same for simulated Existing Condition and the Proposed Action. Sacramento River flow under the Proposed Action is similar to simulated Existing Condition (Figure 3.5-5). The proportion of Sacramento River flow diverted into the DCC and Georgiana Slough under the Proposed Action is generally the same as the proportion diverted under the simulated Existing Condition (Figure 3.5-6), especially during the primary period of juvenile Chinook salmon migration from November through June (Table 3.5-10).

For the San Joaquin River, the flow split at the head of Old River determines the pathway of juvenile fall-run Chinook salmon through the south Delta. Available data indicate that survival of fish continuing down the San Joaquin River past Stockton is higher than survival of fish that move into Old River (San Joaquin River Group Authority 2003; Brandes and McLain 2001). The relationships, however, have not proved to be statistically different over multiple years and variable hydrologic conditions.

Flow in the San Joaquin River is the same under the simulated Existing Condition and the Proposed Action (Figure 3.5-1) and would not affect the proportion of flow drawn into Old River. SWP and CVP pumping is also a factor in the proportion of flow diverted off the San Joaquin River at the head of Old River. The change in CVP and SWP pumping is minimal during April and May

(Figure 3.5-7) and would have little, if any, effect on the proportion of flow drawn into Old River.

Operations under the Proposed Action would have a less-than-significant impact on survival of juvenile Chinook salmon migrating from the Sacramento and San Joaquin Rivers because the proportion of flow diverted off the main river channels is similar to the proportion of flow diverted under the simulated Existing Condition. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Relative to the simulated No Action, the change in flows under the Proposed Action would not be expected to affect migration of adult and juvenile Chinook salmon in Central Valley rivers (Figures 3.5-3 and 3.5-4).

DCC gate operations are the same for No Action and the Proposed Action. Sacramento River flow under the Proposed Action is similar to No Action (Figure 3.5-8). The proportion of Sacramento River flow diverted into the DCC and Georgiana Slough under the Proposed Action is generally the same as the proportion diverted under No Action (Figure 3.5-6).

Flow in the San Joaquin River is the same under the simulated No Action and the Proposed Action (Figure 3.5-3) and would not affect the proportion of flow drawn into Old River. The change in CVP and SWP pumping is relatively small during April and May (Figure 3.5-7) and would have little effect on the proportion of flow drawn into Old River.

As described above for the Existing Condition, operations under the Proposed Action would have a less-than-significant impact on survival of juvenile Chinook salmon migrating from the Sacramento and San Joaquin Rivers. No mitigation is required.

Impact Fish-4: Operations-Related Reduction in Survival of Chinook Salmon in Response to Changes in Water Temperature

Modeled Existing Condition (2001 LOD) Comparison

Changes in reservoir storage and river flows can affect water temperatures in the Sacramento, Feather, and American Rivers. Water temperature in river reaches immediately downstream of the primary reservoirs, including Shasta, Oroville, and Folsom, is the most sensitive to effects of operations. These reaches support Chinook salmon life stages that can be adversely affected by temperature conditions in Central Valley rivers. Flow and related reservoir storage in the San Joaquin River basin are unchanged relative to simulated Existing Condition, and water temperature is not affected (Figure 3.5-1).

Water temperatures in the Sacramento, Feather, and American Rivers are similar under the simulated Existing Condition and the Proposed Action (Figures 3.5-9 and 3.5-10). The changes in water temperature attributable to the Proposed

Table 3.5-10. Life Stage Timing and Distribution of Selected Species Potentially Affected by the Proposed Action

	Distribution	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Late Fall-run Chinook Salmon													
Adult Migration	SF Bay to Upper Sacramento River and Tributaries, Mokelumne River, and San Joaquin River Tributaries												
Spawning	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries												
Juvenile Movement and Rearing	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries												
Fall-run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River and Tributaries												
Spawning[1]	Upper Sacramento River and Tributaries												
Egg Incubation[1]	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Spring-run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing (Natal Stream)	Upper Sacramento River and Tributaries												

Table 3.5-10. Continued

	Distribution	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Winter-run Chinook Salmon													
Adult Migration and Holding	SF Bay to Upper Sacramento River												
Spawning	Upper Sacramento River												
Egg Incubation	Upper Sacramento River												
Juvenile Rearing (Natal Stream)	Upper Sacramento River to SF Bay												
Juvenile Movement and Rearing	Upper Sacramento River to SF Bay												
Steelhead													
Adult Migration	SF Bay to Upper Sacramento River and Tributaries												
Spawning	Upper Sacramento River and Tributaries												
Egg Incubation	Upper Sacramento River and Tributaries												
Juvenile Rearing	Upper Sacramento River and Tributaries to SF Bay												
Juvenile Movement	Upper Sacramento River and Tributaries to SF Bay												
Southern Oregon/Northern California Coasts Coho Salmon													
Adult Migration	Trinity River												
Juvenile Rearing	Trinity River												
Juvenile Movement	Trinity River												
Splittail													
Adult Migration	Suisun Marsh, Upper Delta, Yolo and Sutter Bypasses, Sacramento River and San Joaquin River												
Spawning	Suisun Marsh, Upper Delta, Yolo and Sutter Bypasses, Lower Sacramento and San Joaquin Rivers												

Table 3.5-10. Continued

	Distribution	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Larval and Early Juvenile Rearing and Movement	Suisun Marsh, Upper Delta, Yolo Bypass, Sutter Bypass, Lower Sacramento and San Joaquin Rivers												
Adult and Juvenile Rearing	Delta, Suisun Bay												
Delta Smelt													
Adult Migration	Delta												
Spawning	Delta, Suisun Marsh												
Larval and Early Juvenile Rearing	Delta, Suisun Marsh												
Estuarine Rearing: Juveniles and Adults	Lower Delta, Suisun Bay												

Notes:

Low probability of occurrence, not included in the assessment of the project effect

Primary occurrence included in the assessment of project effects

[1] Spawning and incubation occurs from October to February in the Feather, American, and Mokelumne Rivers

Sources: Brown 1991, Wang and Brown 1993, U.S. Fish and Wildlife Service 1996c, McEwan 2001, Moyle 2002, Hallock 1989.

Action are almost always less than 1°F (0.56°C), although larger changes occur in some simulated months. The potential effect of changes in water temperatures on steelhead and Chinook salmon life stages warrants further consideration of the range of water temperatures affecting survival. Survival indices were assigned to the water temperatures for each month of occurrence of each life stage for Chinook salmon (fall-/late–fall, winter, and spring runs) in the Sacramento, Feather, and American Rivers.

The water temperature survival indices are near optimal in most months under existing conditions for all life stages of all runs in the Sacramento River near Keswick (Table 3.5-11). The indices are similarly high at Bend Bridge and Red Bluff (Tables 3.5-12 and 3.5-13). However, less-than-optimal indices for spawning and incubation are more frequent at RBDD, especially for winter- and spring-run Chinook salmon. The occurrence of lower indices reflects warming of water temperatures downstream from Keswick Dam and Bend Bridge.

Survival indices under the Proposed Action are very similar to those under the simulated Existing Condition, except during a small number of months at Keswick Dam. Table 3.5-14 illustrates the similarity of results between these two simulated conditions. Water temperature conditions supporting spawning and incubation for fall-/late fall–run Chinook salmon and spring-run Chinook salmon decline during a few months but increase in others. The infrequent change in the indices would have a less-than-significant impact on survival, especially given that water temperature conditions are near optimal most of the time.

At Bend Bridge and Red Bluff, change in the survival indices under the Proposed Action is more frequent than occurred at Keswick, especially for winter- and spring-run Chinook salmon spawning and incubation (Tables 3.5-15 and 3.5-16). Water temperature conditions supporting spawning and incubation of winter- and spring-run Chinook salmon decline in some months but improve in more months. The infrequent, small, and generally beneficial change in survival indices would have a less-than-significant impact on survival of Chinook salmon in the Sacramento River.

In the Feather River, suboptimal conditions occur during many months for most life stages of fall-run Chinook salmon under the simulated Existing Condition, especially adult migration (Table 3.5-17). Assessment for spring-run Chinook salmon is included, but most spawning occurs upstream of Thermalito, where water temperature would be nearly the same under the simulated Existing Condition and Proposed Action. Water temperatures in the low-flow section of the Feather River upstream of Thermalito are cooler, and changes in operations under the Proposed Action would not be expected to alter water temperature or adversely affect spawning success of spring-run Chinook salmon. The analysis of water temperature effects on spring-run Chinook salmon below Thermalito is similar to effects described for fall-run Chinook salmon.

Water supply operations under the Proposed Action would generally improve survival indices for adult migration of fall-run Chinook salmon (Table 3.5-18).

For spawning and incubation, reduction in the survival indices occurs more frequently than increases. Given the relatively few months affected and the small change, the reduction in the spawning and incubation indices for fall-run Chinook salmon would have a less-than-significant impact on survival. Improved conditions for adult migration and juvenile rearing may also ameliorate effects on spawning and incubation.

Similar to the Feather River, suboptimal conditions occur in the American River during many months for adult migration and spawning and incubation life stages of fall-run Chinook salmon under the simulated Existing Condition (Table 3.5-19). Water supply operations under the Proposed Action would generally improve survival indices for the spawning and incubation life stage of fall-run Chinook salmon (Table 3.5-20). Water supply operations under the Proposed Action would generally have a beneficial impact on water temperature conditions supporting fall-run Chinook salmon.

Modeled No Action (2020 LOD) Comparison

Flow and related reservoir storage in the San Joaquin River basin are unchanged relative to the simulated No Action, and water temperature is not affected (Figure 3.5-3). Water temperatures in the Sacramento, Feather, and American Rivers are similar under the simulated No Action and the Proposed Action (Figures 3.5-11 and 3.5-12).

The water temperature survival indices are near optimal in most months under the simulated No Action for all life stages of all runs in the Sacramento River near Keswick. (Table 3.5-21). The indices are similarly high at Bend Bridge and Red Bluff (Tables 3.5-22 and 3.5-23).

As described above for the simulated Existing Condition, survival indices under the Proposed Action are very similar to those under the simulated No Action for the Sacramento River (Tables 3.5-24, 3.5-25, and 3.5-26). The infrequent, small, and generally beneficial change in survival indices would have a less-than-significant impact on survival of Chinook salmon in the Sacramento River.

In the Feather River, suboptimal conditions occur during many months for most life stages of fall-run Chinook salmon under the simulated No Action, especially adult migration (Table 3.5-27). As described above for the Existing Condition, operations under the Proposed Action are not expected to alter water temperature or adversely affect spawning success of spring-run and fall-run Chinook salmon (Table 3.5-28). The impact would be less than significant.

Suboptimal conditions occur in the American River during many months for adult migration and spawning and incubation life stages of fall-run Chinook salmon under the simulated No Action (Table 3.5-29). As described above for the Existing Condition, water supply operations under the Proposed Action would generally have a beneficial impact on water temperature conditions supporting fall-run Chinook salmon (Table 3.5-30).

Table 3.5-11. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Keswick for Existing Conditions (2001 LOD), 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	555	553	864	648	576	415	720	504
0.90	8	9	0	0	0	3	0	0
0.80	5	4	0	0	0	1	0	0
0.70	3	0	0	0	0	0	0	0
0.60	5	1	0	0	0	1	0	0
0.50	0	1	0	0	0	0	0	0
0.40	0	0	0	0	0	1	0	0
0.30	0	3	0	0	0	0	0	0
0.20	0	0	0	0	0	0	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	5	0	0	0	11	0	0
	Spring-run Chinook salmon				**Steelhead**			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	492	321	864	576	487	500	864	432
0.90	1	11	0	0	6	3	0	0
0.80	3	5	0	0	3	1	0	0
0.70	3	0	0	0	4	0	0	0
0.60	5	2	0	0	4	0	0	0
0.50	0	1	0	0	0	0	0	0
0.40	0	1	0	0	0	0	0	0
0.30	0	3	0	0	0	0	0	0
0.20	0	0	0	0	0	0	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	16	0	0	0	0	0	0

Table 3.5-12. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Bend Bridge for Existing Conditions (2001 LOD), 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Base Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	546	528	862	648	576	288	718	504
0.90	15	32	2	0	0	99	2	0
0.80	4	3	0	0	0	17	0	0
0.70	3	3	0	0	0	4	0	0
0.60	4	1	0	0	0	3	0	0
0.50	2	2	0	0	0	1	0	0
0.40	0	1	0	0	0	1	0	0
0.30	2	0	0	0	0	2	0	0
0.20	0	0	0	0	0	0	0	0
0.10	0	1	0	0	0	0	0	0
0.00	0	5	0	0	0	17	0	0
	Spring-run Chinook salmon				**Steelhead**			
Base Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	483	261	862	576	479	378	862	432
0.90	7	54	2	0	15	87	2	0
0.80	3	12	0	0	2	27	0	0
0.70	3	4	0	0	2	7	0	0
0.60	4	2	0	0	1	2	0	0
0.50	2	2	0	0	5	0	0	0
0.40	0	1	0	0	0	1	0	0
0.30	2	1	0	0	0	0	0	0
0.20	0	0	0	0	0	1	0	0
0.10	0	1	0	0	0	1	0	0
0.00	0	22	0	0	0	0	0	0

Table 3.5-13. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Red Bluff for Existing Conditions (2001 LOD), 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	536	490	860	648	574	149	716	504
0.90	24	54	4	0	2	151	4	0
0.80	4	17	0	0	0	67	0	0
0.70	2	2	0	0	0	23	0	0
0.60	4	3	0	0	0	9	0	0
0.50	2	1	0	0	0	6	0	0
0.40	2	2	0	0	0	1	0	0
0.30	0	1	0	0	0	3	0	0
0.20	2	0	0	0	0	3	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	6	0	0	0	20	0	0
	Spring-run Chinook salmon				**Steelhead**			
Base Index	Adult Migration	Spawning /Incubatio n	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	471	214	860	576	465	322	860	432
0.90	18	56	4	0	26	80	4	0
0.80	3	34	0	0	5	33	0	0
0.70	2	17	0	0	1	29	0	0
0.60	4	6	0	0	2	12	0	0
0.50	2	5	0	0	4	12	0	0
0.40	2	2	0	0	1	7	0	0
0.30	0	1	0	0	0	2	0	0
0.20	2	1	0	0	0	2	0	0
0.10	0	0	0	0	0	1	0	0
0.00	0	24	0	0	0	4	0	0

Table 3.5-14. Frequency of Change in the Water Temperature Survival Indices from Existing Conditions (2001 LOD) for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Keswick for the Proposed Action, 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	2	0	0	0	1	0	0
<+0.1	8	8	3	0	2	8	3	0
0	563	557	861	648	573	423	717	504
>-0.1	5	9	0	0	1	0	0	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0
	Spring-run Chinook salmon				**Steelhead**			
Change in the Index	Adult Migration	Spawning /Incubatio n	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	3	0	0	0	0	0	0
<+0.1	5	15	3	0	7	1	0	0
0	493	334	861	576	489	501	863	432
>-0.1	6	8	0	0	8	2	1	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-15. Frequency of Change in the Water Temperature Survival Indices from Existing Conditions (2001 LOD) for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Bend Bridge for the Proposed Action, 1922–1994 Simulation

	Fall/Late Fall-Run Chinook Salmon				Winter-Run Chinook			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	1	0	0	0	0	3	0	0
<+0.1	17	12	4	0	2	25	4	0
0	553	557	860	648	572	387	716	504
>-0.1	5	7	0	0	2	17	0	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0
	Spring-run Chinook salmon				**Steelhead**			
Change in the Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	1	1	0	0	0	0	0	0
<+0.1	15	24	4	0	12	13	3	0
0	481	321	860	576	487	489	861	432
>-0.1	7	14	0	0	5	2	0	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-16. Frequency of Change in the Water Temperature Survival Indices from Existing Conditions (2001 LOD) for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Red Bluff for the Proposed Action, 1922–1994 Simulation

	Fall/Late Fall-Run Chinook Salmon				Winter-Run Chinook			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	1	0	0
<+0.2	1	0	0	0	0	4	0	0
<+0.1	18	14	4	0	0	40	4	0
0	553	556	860	648	575	356	716	504
>-0.1	4	6	0	0	1	26	0	0
>-0.2	0	0	0	0	0	5	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

	Spring-run Chinook salmon				Steelhead			
Change in the Index	Adult Migration	Spawning /Incubatio n	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubatio n	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	1	3	0	0	0	0	0	0
<+0.1	18	33	4	0	10	16	4	0
0	480	301	860	576	490	480	860	432
>-0.1	5	22	0	0	4	7	0	0
>-0.2	0	1	0	0	0	0	0	0
>-0.3	0	0	0	0	0	1	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-17. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Feather River at Thermalito for Existing Conditions (2001 LOD), 1922–1994 Simulation

Base Index	Fall-Run Chinook Salmon				Spring-Run Chinook Salmon				Steelhead			
	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	178	345	418	173	144	139	743	572	371	271	736	389
0.90	43	17	9	32	46	11	54	3	57	28	75	32
0.80	20	12	5	6	49	9	28	0	19	12	26	6
0.70	25	8	0	3	47	8	12	1	18	9	13	3
0.60	27	12	0	2	48	11	9	0	25	8	9	2
0.50	24	5	0	0	37	5	8	0	10	8	2	0
0.40	20	4	0	0	25	5	4	0	1	3	1	0
0.30	13	9	0	0	17	9	1	0	2	5	0	0
0.20	10	4	0	0	13	4	2	0	0	5	1	0
0.10	12	2	0	0	14	2	0	0	0	4	0	0
0.00	60	14	0	0	64	157	3	0	1	151	1	0

Table 3.5-18. Frequency of Change in the Water Temperature Survival Indices from Existing Conditions (2001 LOD) for Chinook Salmon and Steelhead Life Stages in the Feather River at Thermalito for the Proposed Action, 1922–1994 Simulation

Change in the Index	Fall-Run Chinook Salmon				Spring-Run Chinook Salmon				Steelhead			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0	0	0	0	0
<+0.2	1	2	0	0	1	2	0	0	1	0	0	0
<+0.1	29	9	4	5	40	8	14	0	14	2	11	5
0	381	406	426	210	436	336	833	576	485	497	842	426
>-0.1	19	15	2	1	25	14	17	0	4	5	11	1
>-0.2	2	0	0	0	2	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.5-19. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the American River at Sunrise for Existing Conditions (2001 LOD), 1922–1994 Simulation

	Fall-Run Chinook Salmon				Steelhead			
Base Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	191	309	420	187	381	278	802	403
0.90	14	47	12	21	38	28	55	21
0.80	3	31	0	8	3	8	6	8
0.70	53	14	0	0	23	9	0	0
0.60	74	6	0	0	35	5	0	0
0.50	41	1	0	0	10	9	0	0
0.40	21	1	0	0	8	4	1	0
0.30	13	3	0	0	2	5	0	0
0.20	7	5	0	0	1	3	0	0
0.10	5	0	0	0	1	4	0	0
0.00	10	15	0	0	2	151	0	0

Table 3.5-20. Frequency of Change in the Water Temperature Survival Indices from Existing Conditions (2001 LOD) for Chinook Salmon and Steelhead Life Stages in the American River at Sunrise for the Proposed Action, 1922–1994 Simulation

Change in the Index	Fall-Run Chinook Salmon				Steelhead			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	1	0	0	0	0	0	0
<+0.2	3	0	0	0	0	0	0	0
<+0.1	24	18	1	2	8	5	9	2
0	379	405	430	213	488	496	850	429
>-0.1	25	6	1	1	8	3	5	1
>-0.2	0	2	0	0	0	0	0	0
>-0.3	1	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-21. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Keswick for No Action (2020 LOD), 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	553	554	864	648	576	413	720	504
0.90	10	7	0	0	0	3	0	0
0.80	5	5	0	0	0	3	0	0
0.70	4	0	0	0	0	0	0	0
0.60	3	0	0	0	0	0	0	0
0.50	1	2	0	0	0	1	0	0
0.40	0	0	0	0	0	1	0	0
0.30	0	1	0	0	0	0	0	0
0.20	0	2	0	0	0	0	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	5	0	0	0	11	0	0
	Spring-run Chinook salmon				**Steelhead**			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	491	321	864	576	487	500	864	432
0.90	2	8	0	0	7	3	0	0
0.80	3	8	0	0	2	1	0	0
0.70	4	0	0	0	2	0	0	0
0.60	3	0	0	0	4	0	0	0
0.50	1	3	0	0	1	0	0	0
0.40	0	1	0	0	1	0	0	0
0.30	0	1	0	0	0	0	0	0
0.20	0	2	0	0	0	0	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	16	0	0	0	0	0	0

Table 3.5-22. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Bend Bridge for No Action (2020 LOD), 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	546	522	863	648	576	282	719	504
0.90	16	38	1	0	0	105	1	0
0.80	3	3	0	0	0	17	0	0
0.70	2	0	0	0	0	4	0	0
0.60	3	4	0	0	0	3	0	0
0.50	5	0	0	0	0	2	0	0
0.40	0	3	0	0	0	1	0	0
0.30	1	0	0	0	0	0	0	0
0.20	0	0	0	0	0	0	0	0
0.10	0	0	0	0	0	1	0	0
0.00	0	6	0	0	0	17	0	0
	Spring-run Chinook salmon				**Steelhead**			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	483	261	863	576	476	374	863	432
0.90	8	52	1	0	17	87	1	0
0.80	2	12	0	0	3	28	0	0
0.70	2	3	0	0	1	10	0	0
0.60	3	5	0	0	1	1	0	0
0.50	5	1	0	0	6	1	0	0
0.40	0	3	0	0	0	1	0	0
0.30	1	0	0	0	0	1	0	0
0.20	0	0	0	0	0	0	0	0
0.10	0	0	0	0	0	1	0	0
0.00	0	23	0	0	0	0	0	0

Table 3.5-23. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Red Bluff for No Action (2020 LOD), 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	534	481	861	648	574	143	717	504
0.90	26	63	3	0	2	159	3	0
0.80	3	17	0	0	0	66	0	0
0.70	2	1	0	0	0	19	0	0
0.60	3	2	0	0	0	12	0	0
0.50	5	2	0	0	0	8	0	0
0.40	2	3	0	0	0	0	0	0
0.30	0	1	0	0	0	2	0	0
0.20	1	0	0	0	0	4	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	6	0	0	0	19	0	0
	Spring-run Chinook salmon				**Steelhead**			
Base Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
1.00	471	210	861	576	465	324	861	432
0.90	18	65	3	0	26	74	3	0
0.80	2	32	0	0	4	32	0	0
0.70	2	10	0	0	2	33	0	0
0.60	3	7	0	0	1	14	0	0
0.50	5	7	0	0	4	9	0	0
0.40	2	3	0	0	2	9	0	0
0.30	0	1	0	0	0	3	0	0
0.20	1	2	0	0	0	2	0	0
0.10	0	0	0	0	0	0	0	0
0.00	0	23	0	0	0	4	0	0

Table 3.5-24. Frequency of Change in the Water Temperature Survival Indices from the No Action (2020 LOD) for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Keswick for the Proposed Action, 1922–1994 Simulation

	Fall/Late Fall-run Chinook salmon				Winter-run Chinook			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	0	0	0	0	0	0	0
<+0.1	7	6	0	0	1	3	0	0
0	567	568	864	648	574	426	720	504
>-0.1	2	2	0	0	1	3	0	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

	Spring-run Chinook salmon				Steelhead			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	0	0	0	0	0	0	0
<+0.1	6	9	0	0	2	1	0	0
0	497	347	864	576	500	502	863	432
>-0.1	1	4	0	0	2	1	1	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-25. Frequency of Change in the Water Temperature Survival Indices from the No Action (2020 LOD) for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Bend Bridge for the Proposed Action, 1922–1994 Simulation

	Fall/Late Fall-Run Chinook Salmon				Winter-Run Chinook			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	0	0	0	0	1	0	0
<+0.1	10	6	0	0	5	21	0	0
0	560	564	864	648	569	395	720	504
>-0.1	6	6	0	0	2	15	0	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0
	Spring-run Chinook salmon				**Steelhead**			
Change in the Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	1	0	0	0	0	0	0
<+0.1	9	25	0	0	5	8	0	0
0	489	327	864	576	495	493	864	432
>-0.1	6	7	0	0	4	3	0	0
>-0.2	0	0	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-26. Frequency of Change in the Water Temperature Survival Indices from No Action (2020 LOD) for Chinook Salmon and Steelhead Life Stages in the Sacramento River at Red Bluff for the Proposed Action, 1922–1994 Simulation

	Fall/Late Fall-Run Chinook Salmon				Winter-Run Chinook			
Change in the Index	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning/ Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	0	0	0	0	4	0	0
<+0.1	11	10	0	0	0	34	0	0
0	558	564	864	648	575	370	720	504
>-0.1	7	2	0	0	1	19	0	0
>-0.2	0	0	0	0	0	5	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0
	Spring-run Chinook salmon				**Steelhead**			
Change in the Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	0	3	0	0	0	1	0	0
<+0.1	11	27	0	0	6	15	0	0
0	487	321	864	576	496	485	864	432
>-0.1	6	8	0	0	2	3	0	0
>-0.2	0	1	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Table 3.5-27. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the Feather River at Thermalito for No Action (2020 LOD), 1922–1994 Simulation

	Fall-Run Chinook Salmon				Spring-Run Chinook Salmon				Steelhead			
Base Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	176	347	414	172	144	141	744	572	371	272	739	388
0.90	45	16	14	35	46	9	61	3	56	26	76	35
0.80	18	8	3	5	46	6	29	0	20	13	26	5
0.70	26	8	1	2	47	8	7	1	18	10	14	2
0.60	29	13	0	2	50	12	9	0	22	9	5	2
0.50	29	8	0	0	43	8	7	0	12	8	2	0
0.40	15	3	0	0	21	4	2	0	4	5	1	0
0.30	15	10	0	0	20	10	1	0	0	2	0	0
0.20	12	4	0	0	16	4	2	0	0	6	0	0
0.10	12	4	0	0	12	4	0	0	0	2	0	0
0.00	55	11	0	0	59	154	2	0	1	151	1	0

Table 3.5-28. Frequency of Change in the Water Temperature Survival Indices from No Action (2020 LOD) for Chinook Salmon and Steelhead Life Stages in the Feather River at Thermalito for the Proposed Action, 1922–1994 Simulation

Change in the Index	Fall-Run Chinook Salmon				Spring-Run Chinook Salmon				Steelhead			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0	0	0	0	0
<+0.3	0	0	0	1	1	0	0	0	0	0	0	1
<+0.2	1	1	1	0	1	1	1	0	0	0	0	0
<+0.1	23	14	2	1	35	14	12	0	7	5	6	1
0	378	406	427	211	429	336	834	576	486	491	845	427
>-0.1	27	11	2	3	35	9	16	0	11	8	12	3
>-0.2	3	0	0	0	3	0	0	0	0	0	1	0
>-0.3	0	0	0	0	0	0	1	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.5-29. Frequency of Water Temperature Survival Indices for Chinook Salmon and Steelhead Life Stages in the American River at Sunrise for the No Action (2020 LOD), 1922–1994 Simulation

	Fall-Run Chinook Salmon				Steelhead			
Base Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	174	305	410	179	358	276	738	395
0.90	27	35	19	20	56	31	110	20
0.80	7	24	2	14	5	6	11	14
0.70	16	20	0	2	7	8	3	2
0.60	61	6	0	0	32	7	1	0
0.50	42	11	1	0	22	6	0	0
0.40	32	2	0	0	12	4	1	0
0.30	28	3	0	1	5	6	0	1
0.20	16	3	0	0	4	4	0	0
0.10	11	2	0	0	1	3	0	0
0.00	18	21	0	0	2	153	0	0

Table 3.5-30. Frequency of Change in the Water Temperature Survival Indices from No Action (2020 LOD) for Chinook Salmon and Steelhead Life Stages in the American River at Sunrise for the Proposed Action, 1922–1994 Simulation

Change in the Index	Fall-Run Chinook Salmon				Steelhead			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0	0	0	0	0
<+0.3	0	0	0	0	0	0	0	0
<+0.2	5	1	0	0	0	0	0	0
<+0.1	29	13	0	1	16	4	9	1
0	362	403	430	213	476	496	848	429
>-0.1	34	13	2	2	12	4	7	2
>-0.2	2	2	0	0	0	0	0	0
>-0.3	0	0	0	0	0	0	0	0
>-0.4	0	0	0	0	0	0	0	0

Impact Fish-5: Operations-Related Increases in Entrainment Losses of Chinook Salmon

Modeled Existing Condition (2001 LOD) Comparison

As indicated previously, simulated SWP and CVP export pumping under the Proposed Action changes compared to pumping under the simulated Existing Condition (Figure 3.5-7). Changes in pumping have the potential to change the amount of entrainment and losses of juvenile Chinook salmon.

Under the simulated Existing Condition, simulated annual losses of fall-run Chinook salmon vary from about 10,000 juveniles to 55,000 juveniles (Figure 3.5-13). Most fall-run Chinook salmon entrainment losses historically have occurred during May. Entrainment losses under the Proposed Action are similar to entrainment losses under the simulated Existing Condition. Simulated annual losses of late fall–run Chinook salmon vary from about 400 juveniles to 1,400 juveniles (Figure 3.5-13). Entrainment losses under the Proposed Action are similar to entrainment losses under the simulated Existing Condition. The impact of the change in entrainment losses on fall- and late fall–run Chinook salmon would be less than significant because increases are small and occur in few years.

Under Existing Condition, simulated annual losses of winter-run Chinook salmon vary from about 1,000 juveniles to 5,000 juveniles (Figure 3.5-13). Entrainment losses increase slightly under the Proposed Action, approaching a 15% increase in one year. The simulated change in entrainment is minimal in most years, and the proportion of annual winter-run production that could be lost would likely be small. In addition, reduced entrainment for some years tends to balance increased entrainment in other years. Based on the juvenile production estimate (JPE), an estimated 30 thousand to 2.3 million winter-run juveniles historically have passed through the Delta each year (1992–2002). Entrainment losses of 5,000 juveniles would make up a relatively small proportion of the total annual winter-run production. Entrainment losses that likely exceed 2% of the annual production would result in reinitiation of consultation with NOAA Fisheries and implementation of measures to ensure that the authorized take is not exceeded (National Marine Fisheries Service 1995). The impact of increased entrainment losses on winter-run Chinook salmon is determined to be less than significant because the increase in proportion of the population lost would likely be small, and reinitiation of consultation would minimize or avoid any substantial increase over existing losses.

Simulated annual losses of spring-run Chinook salmon vary from about 6,000 juveniles to 34,000 juveniles (Figure 3.5-13). Entrainment losses under the Proposed Action increase in one year (from about 6,000 to 7,500 juveniles). The simulated percentage increase is relatively substantial, but the number of juveniles and potential proportion of annual spring-run production lost would likely be small. An estimated 870 thousand to 9 million spring-run juveniles historically have passed through the Delta each year (1992–2002). Entrainment losses of 7,500 juveniles would make up a relatively small proportion (<1%) of the total annual spring-run production. The impact of increased entrainment loss on spring-run Chinook salmon is determined to be less than significant because the increase in proportion of the population lost would likely be small, and changes in entrainment losses for nearly all years are minimal. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Simulated SWP and CVP export pumping under the Proposed Action changes compared to pumping under the simulated No Action (Figure 3.5-7). Under the simulated No Action, the magnitude of losses is similar to that described above for the Existing Condition (Figure 3.5-14). Entrainment losses under the Proposed Action are similar to entrainment losses under the simulated No Action. As described above for the Existing Condition, the impact of the change in entrainment losses on fall- and late fall–run Chinook salmon would be less than significant because increases are small and occur in few years.

Under No Action, simulated annual losses of winter-run Chinook salmon are similar in magnitude to losses described under the simulated Existing Condition (Figure 3.5-14). As described previously for the Existing Condition, the simulated change in entrainment attributable to the Proposed Action is determined to be less than significant because the increase in proportion of the population lost would likely be small, and reinitiation of consultation would minimize or avoid any substantial increase over existing losses.

Simulated annual losses of spring-run Chinook salmon are also similar to the magnitude described for simulated Existing Condition (Figure 3.5-14). As described previously under Existing Condition, the impact of increased entrainment loss on spring-run Chinook salmon attributable to the Proposed Action is determined to be less than significant because the increase in proportion of the population lost would likely be small and changes in entrainment losses for nearly all years are minimal. No mitigation is required.

Impact Fish-6: Operations-Related Reduction in Food Availability for Chinook Salmon

Modeled Existing Condition (2001 LOD) Comparison

Many of the same factors affecting rearing habitat area would be expected to affect food production and availability for juvenile Chinook salmon. Changes in water supply operations potentially affect prey habitat in the Sacramento, Feather, and American Rivers. The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action varies relative to flow under the simulated Existing Condition (Figure 3.5-2). The reduction in flow in some months and increases for other months and years have minimal effect on the range of flows that could affect rearing habitat area for juvenile Chinook salmon (Table 3.5-8) and would likely have minimal effect on habitat supporting prey organisms. In addition, floodplain inundation and availability of food associated with inundation would be similar under the simulated Existing Condition and the Proposed Action. Food availability for

Chinook salmon would not be measurably affected. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action varies relative to flow under the simulated No Action (Figure 3.5-2). As described previously for the Existing Condition, flow effects on rearing habitat area are small (Table 3.5-9) and food availability for Chinook salmon would not be measurably affected. The impact is considered less than significant. No mitigation is required.

Coho Salmon

Effects of implementing the Proposed Action Alternative on coho salmon are discussed for the Trinity River (southern Oregon/northern California coasts evolutionarily significant unit [ESU]). The environmental correlates addressed for coho salmon include spawning habitat quantity, rearing habitat quantity, migration habitat condition, water temperature, and food.

Impact Fish-7: Operations-Related Loss of Spawning Habitat Area for Coho Salmon in the Trinity River

Modeled Existing Condition (2001 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated Existing Condition, with increased flow in a few months (Figure 3.5-1). The changes in flow would not adversely affect spawning habitat area in the Trinity River. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated No Action (Figure 3.5-3). The impact is considered less than significant. No mitigation is required.

Impact Fish-8: Operations-Related Loss of Rearing Habitat Area for Coho Salmon in the Trinity River

Modeled Existing Condition (2001 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated Existing Condition, with increased flow in a few months Figure 3.5-1). The changes in flow would not adversely affect rearing habitat area in the Trinity River. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated No Action (Figure 3.5-3). The impact is considered less than significant. No mitigation is required.

Impact Fish-9: Operations-Related Decline in Migration Habitat Conditions for Coho Salmon in the Trinity River

Modeled Existing Condition (2001 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated Existing Condition, with increased flow in a few months (Figure 3.5-1). The changes in flow would not adversely affect migration habitat conditions in the Trinity River. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated No Action (Figure 3.5-3). The impact is considered less than significant. No mitigation is required.

Impact Fish-10: Operations-Related Reduction in Survival of Coho Salmon in Response to Changes in Water Temperature in the Trinity River

Modeled Existing Condition (2001 LOD) Comparison

Simulated water temperature for the Trinity River is similar for the simulated Existing Condition and the Proposed Action, although substantial changes in water temperature occur in some months (Figure 3.5-15). As indicated previously, changes in Trinity River flow are minimal and would not affect water temperature. The simulated changes in water temperature under the Proposed Action are caused by simulated changes in export of Trinity River water to the Sacramento River (Figure 3.5-16). Although the total water volume exported to the Sacramento River is nearly the same under the simulated Existing Condition and Proposed Action, the monthly volume of Trinity River exports under the Proposed Action varies from the volume exported under the simulated Existing Condition.

Water exported to the Sacramento River is released from Clair Engle Reservoir to Lewiston Reservoir. Lewiston Reservoir discharges flow to the Trinity River and supports export of flow to the Sacramento River. When Clair Engle Reservoir releases are low during warmer months, water traversing Lewiston Reservoir warms considerably prior to release to the Trinity River. Under the Proposed Action, the warming of water temperature in some months coincides with reduced export of Trinity River water, and the cooling coincides with increased export.

Increased water temperature in the Trinity River during the fall months could have an adverse effect on coho salmon and other salmonids. Survival indices were assigned to the water temperature simulated for each month of occurrence for adult migration, spawning, juvenile rearing, and smolt migration life stages of coho salmon in the Trinity River. Water temperature conditions under the simulated Existing Condition are optimal (an index of 1) for most months (Table 3.5-31). For all life stages, the water temperature survival indices are nearly the same for the simulated Existing Condition and the Proposed Action (Table 3.5-32). Changes in water temperature occur within the optimal range for support of coho salmon life stages. The change in water supply operations under the Proposed Action would not affect survival of coho salmon in the Trinity River. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Simulated water temperature for the Trinity River is similar for the simulated No Action and the Proposed Action (Figure 3.5-17). As described previously under the Existing Condition, the simulated changes in water temperature under the Proposed Action are caused by simulated changes in export of Trinity River water to the Sacramento River (Figure 3.5-16). Water temperature conditions under the simulated No Action are optimal for most months (Table 3.5-33). For all life stages, the water temperature survival indices are nearly the same for the simulated No Action and the Proposed Action (Table 3.5-34). As described previously for the Existing Condition, the change in water supply operations under the Proposed Action would not affect survival of coho salmon in the Trinity River. The impact is considered less than significant. No mitigation is required.

Impact Fish-11: Operations-Related Reduction in Food Availability for Coho Salmon in the Trinity River

Modeled Existing Condition (2001 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated Existing Condition, with increased flow in a few months (Figure 3.5-1). The changes in flow would not adversely affect food abundance or availability for coho salmon in the Trinity River. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Flow in the Trinity River under the Proposed Action is nearly the same as flow under the simulated No Action (Figure 3.5-3). The impact is considered less than significant. No mitigation is required.

Steelhead

The following assessment identifies potential impacts of implementing the Proposed Action on Central Valley steelhead. Existing environmental conditions that may be affected by implementing the Proposed Action were discussed briefly in Section 3.5.1 and in more detail in Appendix F. This section assesses the potential effects of those changes on survival, growth, fecundity, and movement of specific life stages of steelhead. Environmental correlates addressed for steelhead include spawning habitat quantity, rearing habitat quantity, migration habitat condition, water temperature, food, and entrainment in diversions.

Impact Fish-12: Operations-Related Effects on Spawning Habitat Area for Steelhead

Modeled Existing Condition (2001 LOD) Comparison

Steelhead spawn in the cool reaches of the Sacramento, Feather, and American Rivers downstream of the terminal reservoirs. Although steelhead also spawn in the tributaries to the San Joaquin River, the simulated flow volume for 1922–1994 for the San Joaquin River and its tributaries under the Proposed Action is nearly identical to the simulated flow under the simulated Existing Condition (Figure 3.5-1). Changes in water supply operations potentially affect spawning habitat area for steelhead in the Sacramento, Feather, and American Rivers (Figure 3.5-2).

The spawning and egg incubation period for steelhead extends from December through June. Flows simulated for the Existing Condition provide near the maximum spawning habitat area during the months of spawning in the Sacramento and Feather Rivers (Table 3.5-4). Change in Sacramento and Feather River flows attributable to water supply operations under the Proposed Action would not affect spawning habitat area (Table 3.5-5). In the American River, spawning habitat area for steelhead is not affected during most months (Table 3.5-5). In general, spawning habitat increases. Given the few spawning months affected and the relatively small change in spawning habitat area, the effect on adult spawning success and survival of steelhead eggs and larvae through incubation in the American River would be minimal. This impact is less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

The simulated flow volume for 1922–1994 for the San Joaquin River and its tributaries under the Proposed Action is nearly identical to the simulated flow under No Action (Figure 3.5-3), and spawning habitat area is not affected. Changes in water supply operations potentially affect spawning habitat area for steelhead in the Sacramento, Feather, and American Rivers (Figure 3.5-4). Flows simulated for No Action provide near the maximum spawning habitat area during the months of spawning in the Sacramento and Feather Rivers (Table 3.5-6). Change in Sacramento and Feather River flows attributable to water supply

Table 3.5-31. Frequency of Water Temperature Survival Indices for Coho Salmon (based on criteria for Chinook salmon) in the Trinity River at Lewiston for Existing Conditions (2001 LOD), 1922–1994 Simulation

	Coho Salmon			
Base Index	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	281	288	864	288
0.90	6	0	0	0
0.80	1	0	0	0
0.70	0	0	0	0
0.60	0	0	0	0
0.50	0	0	0	0
0.40	0	0	0	0
0.30	0	0	0	0
0.20	0	0	0	0
0.10	0	0	0	0
0.00	0	0	0	0

Table 3.5-32. Frequency of Change in the Water Temperature Survival Indices from Existing Conditions (2001 LOD) for Coho Salmon Life Stages in the Trinity River at Lewiston for the Proposed Action, 1922–1994 Simulation

Change in the Index	Coho Salmon			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0
<+0.3	0	0	0	0
<+0.2	0	0	0	0
<+0.1	1	0	0	0
0	287	288	864	288
>-0.1	0	0	0	0
>-0.2	0	0	0	0
>-0.3	0	0	0	0
>-0.4	0	0	0	0

Table 3.5-33. Frequency of Water Temperature Survival Indices for Coho Salmon (based on criteria for Chinook salmon) in the Trinity River at Lewiston for No Action (2020 LOD), 1922–1994 Simulation

Base Index	Coho Salmon			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
1.00	283	288	864	288
0.90	4	0	0	0
0.80	1	0	0	0
0.70	0	0	0	0
0.60	0	0	0	0
0.50	0	0	0	0
0.40	0	0	0	0
0.30	0	0	0	0
0.20	0	0	0	0
0.10	0	0	0	0
0.00	0	0	0	0

Table 3.5-34. Frequency of Change in the Water Temperature Survival Indices from No Action (2020 LOD) for Coho Salmon Life Stages in the Trinity River at Lewiston for the Proposed Action, 1922–1994 Simulation

Change in the Index	Coho Salmon			
	Adult Migration	Spawning /Incubation	Juvenile Rearing	Smolt Migration
<+0.4	0	0	0	0
<+0.3	0	0	0	0
<+0.2	0	0	0	0
<+0.1	0	0	0	0
0	285	288	863	288
>-0.1	3	0	1	0
>-0.2	0	0	0	0
>-0.3	0	0	0	0
>-0.4	0	0	0	0

operations under the Proposed Action would not affect spawning habitat area (Table 3.5-7). In the American River, spawning habitat area for steelhead is not affected during most months (Table 3.5-7). As explained previously for the Existing Condition, the impact is considered less than significant. No mitigation is required.

Impact Fish-13: Operations-Related Loss of Rearing Habitat Area for Steelhead

Modeled Existing Condition (2001 LOD) Comparison

Changes in water supply operations potentially affect rearing habitat area for steelhead in the Sacramento, Feather, and American Rivers. Rearing occurs year-round in the cool reaches below the terminal reservoirs. The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action varies relative to flow under the simulated Existing Condition (Figure 3.5-2). The reduction in flow in some months and increases in other months and years have minimal effect on the range of flows that could affect rearing habitat area (Table 3.5-8). The impact on steelhead would be less than significant because rearing habitat in most months of most years is unaffected. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action varies relative to flow under simulated No Action (Figure 3.5-4). As described previously for the Existing Condition, flows affecting rearing habitat area are minimally affected by the Proposed Action, and the impact on steelhead would be less than significant. No mitigation is required.

Impact Fish-14: Operations-Related Decline in Migration Habitat Conditions for Steelhead

Modeled Existing Condition (2001 LOD) Comparison

The Sacramento, Feather, and American Rivers provide a migration pathway between freshwater and marine habitats for steelhead. Flows that occur in Central Valley rivers generally support migration of adult and juvenile steelhead. Relative to the simulated Existing Condition, the change in flows under the Proposed Action would not be expected to affect migration of adult and juvenile steelhead in Central Valley rivers (Figures 3.5-1 and 3.5-2).

In the Delta, juvenile Chinook salmon survival is lower for fish migrating through the central Delta than for fish continuing down the Sacramento River channel (Brandes and McLain 2001; Newman and Rice 1997). A similar relationship is assumed for juvenile steelhead. Juvenile steelhead begin entering the Delta from upstream habitat in the Sacramento River and its tributaries during December. Downstream movement and migration continue through May or June. Few juvenile steelhead move through the Delta from July through

November. As described for Chinook salmon, operations under the Proposed Action would have a less-than-significant impact on survival of juvenile steelhead migrating from the Sacramento and San Joaquin Rivers because the proportion of flow diverted off the main river channels is similar to the proportion of flow diverted under the simulated Existing Condition. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Relative to the simulated No Action condition, the change in flows under the Proposed Action would not be expected to affect migration of adult and juvenile steelhead in Central Valley rivers (Figures 3.5-3 and 3.5-4).

As described previously under the Existing Condition, operations under the Proposed Action would have a less-than-significant impact on survival of juvenile steelhead migrating from the Sacramento and San Joaquin Rivers. No mitigation is required.

Impact Fish-15: Operations-Related Reduction in Survival of Steelhead in Response to Changes in Water Temperature

Modeled Existing Condition (2001 LOD) Comparison

Change in reservoir storage and river flow potentially affects water temperature in the Sacramento, Feather, and American Rivers. Water temperature in river reaches immediately downstream of the primary reservoirs, including Shasta, Oroville, and Folsom, is the most sensitive to effects of operations. These reaches support steelhead life stages that can be adversely affected by temperature conditions in Central Valley rivers.

Water temperatures in the Sacramento, Feather, and American Rivers are similar under the simulated Existing Condition and the Proposed Action (Figures 3.5-9 and 3.5-10). The change in water temperature attributable to the Proposed Action is almost always less than 1°F (0.56°C), although larger changes occur in some simulated months. The potential effect of water temperature on steelhead life stages warrants further consideration of the range of water temperatures affecting survival. Survival indices were assigned to the water temperatures for each month of occurrence of each life stage for steelhead in the Sacramento, Feather, and American Rivers.

For all life stages in the Sacramento River near Keswick, the water temperature survival indices are near optimal in most months under the simulated Existing Condition (Table 3.5-11). The indices are similarly high at Bend Bridge and Red Bluff (Tables 3.5-12 and 3.5-13), although less-than-optimal indices are more frequent for spawning and incubation. The occurrence of lower indices reflects warming of water temperatures downstream from Keswick and Bend Bridge.

The few months of change in survival indices at Keswick under the Proposed Action illustrate the similarity to indices under the simulated Existing Condition

(Table 3.5-14). The infrequent change in the indices would not affect survival. Change in the survival indices under the Proposed Action is slightly more frequent At Bend Bridge and Red Bluff than at Keswick (Tables 3.5-15 and 3.5-16). Water temperature conditions supporting adult migration and spawning and incubation improve in some months. Other than the benefit to adult migration and spawning and incubation at Bend Bridge and Red Bluff, water temperature survival indices for steelhead life stages in the Sacramento River are nearly the same under the simulated Existing Condition and the Proposed Action.

In the Feather River, suboptimal conditions occur during many months for most life stages under the simulated Existing Condition, especially for adult migration and juvenile rearing (Table 3.5-17). Water supply operations under the Proposed Action would generally improve survival indices for adult migration (Table 3.5-18). For other life stages, relatively few months are affected and changes are small. Change in water temperature would have a less-than-significant impact on survival. No mitigation is required.

Similar to the Feather River, suboptimal conditions occur in the American River during many months for adult migration and spawning and incubation under the simulated Existing Condition (Table 3.5-16a). Water supply operations under the Proposed Action would slightly improve survival indices for juvenile rearing (Table 3.5-20). Water supply operations under the Proposed Action would have less-than-significant effects on water temperature conditions and support of steelhead life stages. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Water temperatures in the Sacramento, Feather, and American Rivers are similar under simulated No Action and the Proposed Action (Figures 3.5-11 and 3.5-12). For all life stages in the Sacramento River near Keswick, the water temperature survival indices are near optimal in most months under simulated No Action (Table 3.5-21). The indices are similarly high at Bend Bridge and Red Bluff (Tables 3.5-22 and 3.5-23).

The few months of change in survival indices at Keswick under the Proposed Action illustrate the similarity to indices under simulated No Action (Table 3.5-24). Change in the survival indices under the Proposed Action is slightly more frequent at Bend Bridge and Red Bluff than at Keswick (Tables 3.5-25 and 3.5-26). In the Feather River, suboptimal conditions occur during many months for most life stages under simulated No Action, especially for adult migration and juvenile rearing (Table 3.5-27). Water supply operations under the Proposed Action would generally improve survival indices for adult migration (Table 3.5-28). Suboptimal conditions also occur in the American River during many months for adult migration and spawning and incubation under simulated No Action (Table 3.5-29). Water supply operations under the Proposed Action would slightly improve survival indices for juvenile rearing (Table 3.5-30).

As described previously for the Existing Condition, change in water temperature would have a less-than-significant impact on survival in Central Valley rivers. No mitigation is required.

Impact Fish-16: Operations-Related Increases in Entrainment Losses of Steelhead

Modeled Existing Condition (2001 LOD) Comparison

Change in pumping potentially alters entrainment and salvage of juvenile steelhead. Under the simulated Existing Condition, simulated annual salvage of steelhead varies from about 1,000 juveniles to 4,500 juveniles (Figure 3.5-18a). Salvage, and hence entrainment losses, are projected to be similar under the simulated Existing Condition and the Proposed Action, with increased salvage in a few years. Although the simulated increase in salvage in one year is near 10%, actual salvage levels are less than 1,000 juveniles. The proportion of annual steelhead production entrained is currently unknown, but the effect would likely be similar to effects described for spring-run Chinook salmon. The impact of increased entrainment losses on steelhead is determined to be less than significant because the proportion of the population entrained is likely small and increased entrainment would be infrequent and balanced by reduced entrainment in other years. In addition, juvenile steelhead are larger than juvenile Chinook salmon, and indirect and direct effects of SWP and CVP pumping on survival of a steelhead year class are expected to be less than the effects described for juvenile Chinook salmon. The larger size results in higher screening efficiency and likely increases the ability of individuals to avoid predators. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Under No Action and the Proposed Action, simulated annual salvage of steelhead varies in magnitude, similar to that described for the simulated Existing Condition (Figure 3.5-18b). As described previously for the Existing Condition, the impact of increased entrainment losses on steelhead is determined to be less than significant. No mitigation is required.

Impact Fish-17: Operations-Related Reduction in Food Availability for Steelhead

Modeled Existing Condition (2001 LOD) Comparison

Many of the same factors affecting rearing habitat area would be expected to affect food production and availability for steelhead. Changes in water supply operations potentially affect prey habitat in the Sacramento, Feather, and American Rivers. The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action is similar to flow under the simulated Existing Condition (Figure 3.5-2). Effects on food availability for steelhead would not be expected. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

The flow simulated for 1922–1994 in the Sacramento, Feather, and American Rivers for the Proposed Action is similar to flow under simulated No Action (Figure 3.5-4). Effects on food availability for steelhead would be the same as described previously for the Existing Condition. The impact is considered to be less than significant. No mitigation is required.

Delta Smelt

The following assessment identifies potential impacts of implementing the Proposed Action on delta smelt. Delta smelt occur primarily within the Delta and Suisun Bay, with sporadic occurrence in San Pablo Bay and frequent occurrence in the Napa River estuary. Delta smelt do not occur in the rivers upstream of the Delta. The environmental conditions in the Delta that are affected under the Proposed Action were briefly discussed in Section 3.5.1 and in more detail in Appendix F. This section assesses the potential effects of those changes on survival, growth, fecundity, and movement of specific life stages. Environmental correlates addressed for delta smelt include spawning habitat quantity, rearing habitat quantity, migration habitat condition, food, and entrainment in diversions.

Impact Fish-18: Operations-Related Loss of Spawning Habitat Area for Delta Smelt

Modeled Existing Condition (2001 LOD) Comparison

Delta smelt spawn in the Delta. As indicated in the description of methods in Appendix F, existing information does not indicate that spawning habitat is limiting population abundance and production (U.S. Fish and Wildlife Service 1996). The extent of salinity intrusion into the Delta, as represented by the change in location of X2, provides an index of potential effects of water supply operations on spawning habitat availability throughout the Delta. Delta smelt spawn primarily from January through May. Water supply operations under the Proposed Action would have little effect on the location of X2 during the spawning period (Figure 3.5-19a) because the change in location of X2 during the spawning period is less than 1 kilometer, indicating relatively minor intrusion into Delta spawning areas. Operations under the Proposed Action would have minimal effect on spawning habitat in the Delta. This impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Water supply operations under the Proposed Action, relative to operations under simulated No Action, would have little effect on the location of X2 during the spawning period (Figure 3.5-19b). For reasons similar to those described previously for the Existing Condition, the impact is considered to be less than significant. No mitigation is required.

Impact Fish-19: Operations-Related Loss of Rearing Habitat Area for Delta Smelt

Modeled Existing Condition (2001 LOD) Comparison

Delta smelt larvae and juveniles rear in the Delta and Suisun Bay, and adults also occur there. Changes in water supply operations potentially affect estuarine rearing habitat area for delta smelt. The location of the preferred salinity range for delta smelt in the Delta and Suisun Bay is assumed to determine estuarine rearing habitat area. The range of salinity preferred by delta smelt (i.e., 0.3 ppt to 1.8 ppt) was used to calculate the estuarine rearing habitat area for each month under the simulated Existing Condition (proportion of the maximum area available for any month of the 1922–1994 simulation) (Figure 3.5-20a). The proportion of the maximum rearing habitat area available ranged from about 25% to 100% depending on the month. The primary months that estuarine rearing habitat is important to survival of a year class are not precisely known, but it appears to be most important from March through July (Unger 1994). During most simulated years, the proportion of maximum habitat area available exceeded 60% during the important months for rearing. Given the occurrence of delta smelt in estuarine rearing habitat through November and December, habitat area could also affect survival in those months. Habitat availability is generally lowest from September through December (Figure 3.5-20a).

As indicated previously, comparison of X2 for simulated Existing Condition and the Proposed Action indicates that for October through January the salinity distribution shifts upstream in some months under the Proposed Action (Figure 3.5-19a). The change in rearing habitat area attributable to water supply operations under the Proposed Action reflects a similar pattern, although both reductions and increases in habitat area occur (Figure 3.5-21a). The change in estuarine rearing habitat area under the Proposed Action is small (generally less than 5%) and infrequent for most years during all months. Given the few rearing months affected, especially during April through August, and the relatively small change in estuarine rearing habitat area, effects on survival of delta smelt would be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Rearing habitat availability under the simulated No Action condition is similar to habitat availability described for the simulated Existing Condition (Figure 3.5-20b). The change in rearing habitat area is also similar to the change described previously for the Existing Condition (Figure 3.5-21b). The impact is considered to be less than significant. No mitigation is required.

Impact Fish-20: Operations-Related Decline in Migration Habitat Conditions for Delta Smelt

Modeled Existing Condition (2001 LOD) Comparison

Water supply operations under the Proposed Action would change SWP and CVP pumping and Delta inflow and outflow (Figures 3.5-5 and 3.5-7). Net flow in the Delta channels could be affected (Section 3.3, Delta Tidal Hydraulics). Although net channel flows have been identified as important because they move fish downstream (U.S. Fish and Wildlife Service 1996), actual effects of net flow changes on the movement of adult, larvae, and juvenile delta smelt have not been demonstrated. Given that net flow changes attributable to water supply operations are small relative to tidal flows, effects on delta smelt are likely minimal. The impact is considered to be less than significant. No mitigation is required. Potential effects of flow changes on survival of larval and juvenile delta smelt are addressed in the following section on entrainment.

Modeled No Action (2020 LOD) Comparison

Water supply operations under the Proposed Action would change SWP and CVP pumping and Delta inflow and outflow (Figures 3.5-7 and 3.5-87). As described previously for the simulated Existing Condition, net flow changes attributable to water supply operations are small, and the impact is considered to be less than significant. No mitigation is required.

Impact Fish-21: Operations-Related Increases in State Water Project Pumping and Resulting Entrainment Losses of Delta Smelt

Modeled Existing Condition (2001 LOD) Comparison

Change in CVP and SWP pumping potentially alters entrainment and salvage of juvenile delta smelt. Under the simulated Existing Condition, simulated annual salvage of delta smelt varies from about 7,000 to 35,000 individuals (Figure 3.5-22a). Most delta smelt (about 90%) are salvaged during May–July. Salvage generally decreases under the Proposed Action, although the average change for the simulated period (i.e., 1922–1994) is minimal (Figure 3.5-22a). Increased salvage in one year approaches 10%, and reduced salvage in one year approaches 20%.

Although loss of juveniles does not represent the same impact as loss of adults (i.e., a substantial proportion of juveniles would naturally not survive to become adults), the proportion of annual delta smelt production lost to entrainment is currently unknown. Increases and reductions in salvage under the Proposed Action occur primarily during May–July, when more than 90% of the annual change in delta smelt salvage occurs (Figure 3.5-23). During the May–July period, salvage consists mostly of 20–30-mm juveniles (Figure 3.5-24). Based on the 20-mm survey data, most juvenile smelt occur in Suisun Bay and near the confluence of the Sacramento and San Joaquin Rivers from April through July (Table 3.5-35). A substantial proportion of the population may, however, occur within the central and south Delta during April and May and possibly during June and July.

Operations under the Proposed Action would have a less-than-significant impact because the change in entrainment is generally small and only part of the population would be affected. The small changes in entrainment would not likely affect population abundance. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Under No Action and the Proposed Action, simulated annual salvage of delta smelt varies in magnitude similar to that described for the simulated Existing Condition (Figure 3.5-22b). However, a substantial increase in modeled entrainment (i.e., greater than 50%) occurs in 1961. The increased entrainment is attributable to a simulated increase in SWP pumping in June (from 1,167 cfs under No Action to 3,166 cfs under the Proposed Action). The simulated change in pumping is attributable to rules within the CALSIM II model and does not represent changes in SWP pumping that would be expected with actual implementation of the Proposed Action. Smaller increases and decreases in entrainment are attributable to changes in SWP pumping simulated primarily during June of other years. Consequently, the variability in entrainment simulated for the Existing Condition (Figure 3.5-22a) is more representative of the expected changes in entrainment of delta smelt with implementation of the Proposed Action. As described previously for the Existing Condition, the impact of increased entrainment losses on delta smelt is considered to be less than significant. No mitigation is required.

Impact Fish-22: Operations-Related Reduction in Food Availability for Delta Smelt

Modeled Existing Condition (2001 LOD) Comparison

Many of the same factors affecting rearing habitat area would be expected to affect food production and availability for delta smelt. As discussed earlier for rearing habitat area, changes in water supply operations potentially affect estuarine rearing habitat area for delta smelt in the Delta and Suisun Bay. Location of rearing habitat area downstream of the Delta is believed to increase food availability for delta smelt (U.S. Fish and Wildlife Service 1996). The broad and shallow areas of Suisun Bay allow algae to grow and reproduce rapidly, providing food for zooplankton, which are food for delta smelt. Greater rearing habitat area for delta smelt coincides with location downstream of the Delta and within the areas of higher zooplankton production. The change in estuarine rearing habitat area under the Proposed Action is small (generally less than 5%) and infrequent for most years during all months (Figure 3.5-21a). Given the few rearing months affected, especially during April through August, and the relatively small change in estuarine rearing habitat area, effects on food availability for delta smelt would be less than significant. No mitigation is required.

Table 3.5-35. Monthly Median and Maximum Proportion (%) of Delta Smelt Distributed within Specific Areas of the Sacramento-San Joaquin Delta Estuary, 20-mm Survey Data

Location	Mar	Apr	May	Jun	Jul	August
Median						
Suisun+	0	14	16	30	31	0
Confluence	0	9	19	22	29	0
Central Delta	0	12	14	12	0	0
South Delta	0	11	18	6	0	0
Stockton	0	3	0	8	0	0
Maximum						
Suisun+	68	60	27	54	48	40
Confluence	68	67	29	31	53	25
Central Delta	6	19	22	23	0	0
South Delta	11	13	27	22	0	0
Stockton	0	17	32	55	0	0

Delta smelt feed on zooplankton; consequently prey organisms may be subject to entrainment effects similar to those described above for larval and juvenile delta smelt in the central and south Delta. Entrainment loss of food organisms and its effect on delta smelt productivity is currently unknown. The effect, however, is not clearly separable from entrainment loss of delta smelt. The impact of entrainment on food sources is assumed to be encompassed by the impact described for delta smelt (Impact Fish-21).

Modeled No Action (2020 LOD) Comparison

The change in estuarine rearing habitat area under the Proposed Action is small (generally less than 5%) and infrequent for most years during all months (Figure 3.5-21b). As described previously for the Existing Condition, the relatively small change in estuarine rearing habitat would have a less-than-significant impact on food availability for delta smelt. No mitigation is required.

Splittail

The following assessment identifies potential impacts of implementing the Proposed Action on splittail. Adult and juvenile splittail spend most of their lives in the Delta and Suisun Bay. Splittail are dependent on conditions upstream of the Delta for rearing and spawning, especially inundated floodplain in the Yolo and Sutter Bypasses. The environmental conditions affected under the Proposed Action were discussed briefly in Section 3.5.1 and in more detail in Appendix F. This section assesses the potential effects of those changes on survival, growth, fecundity, and movement of specific life stages. Environmental correlates addressed for splittail include spawning habitat quantity, rearing habitat quantity, migration habitat condition, food, and entrainment in diversions.

Impact Fish-23: Operations-Related Loss of Spawning Habitat Area for Splittail

Modeled Existing Condition (2001 LOD) Comparison

The extent of salinity intrusion into the Delta, as represented by the change in location of X2, provides an index of potential effects of water supply operations on spawning habitat availability throughout the Delta. Splittail spawn primarily from February through May. Water supply operations under the Proposed Action would affect the location of X2 (Figure 3.5-19a). The location of X2 during the spawning period for splittail is nearly the same under the simulated Existing Condition and the Proposed Action. The change in location of X2 during the spawning period is generally less than 1 kilometer, indicating relatively minor intrusion into Delta spawning areas. Operations under the Proposed Action would have minimal effect (i.e., a less-than-significant impact) on spawning habitat in the Delta.

Splittail spawn primarily upstream of the Delta and use vegetated areas on inundated floodplain or along the edge of the river channel (Sommer et al. 2001).

Inundated floodplain in the Yolo and Sutter Bypasses provides important spawning habitat for splittail. Changes in water supply operations affect reservoir storage and may affect the frequency of floodplain inundation. The small changes in river flows under the Proposed Action do not affect higher volume flows (Figure 3.5-2). The frequency and duration of floodplain inundation would be similar for the simulated Existing Condition and the Proposed Action, and spawning habitat area would not be affected. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Water supply operations under the Proposed Action would affect the location of X2 (Figure 3.5-19b). As described for the simulated Existing Condition, operations under the Proposed Action would have minimal effect (i.e., a less-than-significant impact) on spawning habitat in the Delta. The small changes in river flows under the Proposed Action also do not affect higher volume flows (Figure 3.5-4). As described previously for the Existing Condition discussion, floodplain spawning habitat would not be affected. The impact is considered to be less than significant. No mitigation is required.

Impact Fish-24: Operations-Related Loss of Rearing Habitat Area for Splittail

Modeled Existing Condition (2001 LOD) Comparison

Inundated floodplain in the Yolo and Sutter Bypasses provides important rearing habitat for larval and juvenile splittail (Sommer et al. 1997). As discussed above for spawning habitat area, the small changes in river flows under the Proposed Action do not affect higher volume flows (Figure 3.5-2). The frequency and duration of floodplain inundation would be similar for the simulated Existing Condition and the Proposed Action, and rearing habitat area would not be affected. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

As discussed above for the simulated Existing Condition, the small changes in river flows under the Proposed Action do not affect higher volume flows (Figure 3.5-4), and rearing habitat area would not be affected. The impact is considered to be less than significant. No mitigation is required.

Impact Fish-25: Operations-Related Decline in Migration Habitat Conditions for Splittail

Modeled Existing Condition (2001 LOD) Comparison

The Sacramento River provides a migration pathway between freshwater and estuarine habitats for splittail. Flows that occur in the Sacramento River generally support migration of adult splittail. As indicated above for spawning and rearing habitat area, the small changes in river flows under the Proposed Action do not affect higher volume flows (Figure 3.5-2). The frequency and duration of floodplain inundation would be similar for the simulated Existing Condition and the Proposed Action and would not affect conditions supporting migration on and off the floodplain. The impact is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

As indicated above for the Existing Condition, the small changes in river flows under the Proposed Action do not affect higher volume flows (Figure 3.5-4) and would not affect conditions supporting migration on and off the floodplain. The impact is considered less than significant. No mitigation is required.

Impact Fish-26: Operations-Related Increases in Entrainment Losses of Splittail

Modeled Existing Condition (2001 LOD) Comparison

Change in CVP and SWP pumping potentially alters entrainment and salvage of juvenile splittail. Under simulated Existing Condition, annual salvage of splittail varies from about 20,000 to 70,000 individuals over the simulated 1922–1994 period (Figure 3.5-25a). Highest salvage densities occur during May and June. The median length of splittail salvaged during May and June is 50 mm or less (Figure 3.5-26), indicating entrainment of juveniles originating from spawning during the current year. High salvage coincides with high juvenile abundance during wet years (U.S. Fish and Wildlife Service 1995).

On average, salvage is similar for the simulated Existing Condition and the Proposed Action (Figure 3.5-25a). In some years salvage increases, but remains less than 10%, and in others, salvage is reduced but remains more than 10%. The impact of entrainment on splittail abundance is determined to be less than significant. The conclusion is based on the relatively small change in salvage attributable to the Proposed Action and the observed distribution of splittail spawning and rearing. Most splittail spawning and early rearing appears to occur over floodplain inundated by the Sacramento River, including the Yolo and Sutter Bypasses (Sommer et al. 1997). Given that most splittail enter the Delta from the Sacramento River system and move into Suisun Bay and Marsh, the exposure to entrainment by SWP and CVP pumping would be relatively low. Although information to determine the population level impact is not available, the impact would likely be similar to that described for fall-run Chinook salmon that enter the Delta from the Sacramento River. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Under No Action and the Proposed Action, simulated annual salvage of splittail varies in magnitude similar to that described for simulated Existing Condition (Figure 3.5-25b). However, a substantial increase in entrainment (i.e., greater than 30%) is shown in 1961. As explained under the impact discussion for delta smelt, the increase does not represent changes in SWP pumping that would be expected with actual implementation of the Proposed Action Alternative. As described previously for the simulated Existing Condition, the impact of increased entrainment losses on splittail is determined to be less than significant. No mitigation is required.

Impact Fish-27: Operations-Related Reduction in Food Availability for Splittail

Modeled Existing Condition (2001 LOD) Comparison

Inundated floodplain in the Yolo and Sutter Bypasses provides important access by fish to prey organisms and input of nutrients to the rivers and Delta (Sommer et al. 2001; Sommer et al. 2000). As previously discussed for splittail rearing habitat, changes in water supply operations under the Proposed Action would not affect access to floodplain rearing habitat during the primary period of splittail occurrence or input of nutrients with runoff from floodplain habitat. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

The impact is the same as described above for the Existing Condition. The impact is considered to be less than significant. No mitigation is required.

Striped Bass

The following assessment identifies potential impacts of implementing the Proposed Action on striped bass. Striped bass occur in the Delta, Suisun Bay, San Francisco Bay, and the coastal waters near San Francisco Bay. Adult striped bass migrate upstream to the Delta and into the Sacramento River to spawn. Some juvenile and adult striped bass occur in rivers upstream of the Delta throughout the year. The environmental conditions affected under the Proposed Action were discussed briefly in Section 3.5.1 and in more detail in Appendix F. This section assesses the potential effects of those changes on survival, growth, fecundity, and movement of specific life stages. Environmental correlates addressed for striped bass include spawning habitat quantity, rearing habitat quantity, migration habitat condition, food, and entrainment in diversions.

Impact Fish-28: Operations-Related Effects on Spawning Habitat Area for Striped Bass

Modeled Existing Condition (2001 LOD) Comparison

Striped bass spawn in the Delta and in the Sacramento River upstream of the Delta (California Department of Fish and Game 1987). Eggs are released into the water column. They are semibuoyant and drift with the currents. Eggs spawned in the Sacramento River drift downstream to the Delta. Larvae and early juveniles rear near the 2-ppt isohaline (i.e., represented by X2 location) in the lower Delta and, depending on salinity conditions, Suisun Bay. Spawning in the Sacramento River upstream of the Delta occurs during May and June. Spawning in the Delta occurs during April and May, usually within the San Joaquin River channel between Antioch and Venice Island (California Department of Fish and Game 1987).

The extent of salinity intrusion into the Delta, as represented by the change in location of X2, provides an index of potential effects of water supply operations on spawning habitat availability in the Delta. While water supply operations under the Proposed Action could affect the location of X2 (Figure 3.5-19a), the location of X2 during the spawning period for striped bass is nearly the same under the simulated Existing Condition and the Proposed Action. Water supply operations under the Proposed Action would have minimal effect on spawning habitat in the Delta. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

As described previously under the Existing Condition discussion, the location of X2 during the spawning period for striped bass is nearly the same under simulated No Action and the Proposed Action (Figure 3.5-19a). The impact on spawning habitat is considered to be less than significant. No mitigation is required.

Impact Fish-29: Operations-Related Loss of Rearing Habitat Area for Striped Bass

Modeled Existing Condition (2001 LOD) Comparison

Striped bass larvae and juveniles rear in the Delta and Suisun Bay. Changes in water supply operations potentially affect estuarine rearing habitat area for striped bass in the Delta and Suisun Bay. The location of the preferred salinity range for striped bass in the Delta and Suisun Bay is assumed to determine estuarine rearing habitat area. The range of salinity preferred by striped bass larvae and early juveniles (0.1 ppt to 2.5 ppt) was used to calculate the estuarine rearing habitat area for each month under the Existing Condition (i.e., proportion of the maximum area available for any month of the 1922–1994 simulation) (Figure 3.5-27a). Proportional rearing habitat area ranged from about 40% to 100% depending on the month. The primary months that estuarine rearing habitat is important to survival of a year class are not precisely known, but it appears to be most important from April through June (Unger 1994). During most simulated years, the proportional habitat area exceeded 80% during the important months for larval rearing (Figure 3.5-27a).

As indicated previously, comparison of X2 for the simulated Existing Condition and the Proposed Action indicates that for most months salinity distribution is similar (Figure 3.5-19a). The change in rearing habitat area attributable to water supply operations under the Proposed Action reflects the similarity to existing conditions (Figure 3.5-28a). The change in estuarine rearing habitat area under the Proposed Action is small (generally less than 5%) and infrequent for most years during all months. Given the few rearing months affected during April through June, and the relatively small change in estuarine rearing habitat area, effects on survival of striped bass would be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Proportional rearing habitat area for the simulated No Action condition and change under the Proposed Action are similar to the description above under Existing Condition (Figures 3.5-27b and 3.5-28b). As described previously for the Existing Condition, the change in estuarine rearing habitat area under the Proposed Action is small and infrequent, and effects on survival of striped bass would be less than significant. No mitigation is required.

Impact Fish-30: Operations-Related Decline in Migration Habitat Conditions for Striped Bass

Modeled Existing Condition (2001 LOD) Comparison

Water supply operations could affect Sacramento River flow and survival of striped bass eggs and larvae (California Department of Fish and Game 1992). Higher flows (greater than 17,000 cfs) appear to result in higher egg survival. The mechanism for higher survival could be related to duration of transport, larval food availability, suspension of eggs within the water column, or other factors.

Spawning in the Sacramento River upstream of the Delta occurs during May and June. Simulated Sacramento River flow under the Proposed Action would be similar to flow under the simulated Existing Condition (Figure 3.5-5). Notable reductions in flow occur in one month of the 1922–1994 May–June simulation (i.e., flow is reduced by more than 1,000 cfs). The affected flow under the simulated Existing Condition is reduced from 13,600 cfs to 12,500 cfs. The reduction in Sacramento River flow would have a less-than-significant impact on egg movement and survival in the Sacramento River because only one month in one year is affected, and the flow changes are within the range of flows that do not clearly support higher egg survival. The impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Simulated Sacramento River flow under the Proposed Action would be similar to flow under simulated No Action (Figure 3.5-8). As described previously for the Existing Condition, changes in Sacramento River flow would have a less-than-significant impact on egg movement and survival in the Sacramento River. No mitigation is required.

Impact Fish-31: Operations-Related Increases in State Water Project Pumping and Resulting Entrainment Losses of Striped Bass

Modeled Existing Condition (2001 LOD) Comparison

Change in CVP and SWP pumping potentially alters entrainment and salvage of juvenile striped bass. Under the simulated Existing Condition, simulated annual salvage of striped bass varies from about 1 million to 7 million individuals (Figure 3.5-29a). Most striped bass (about 90%) are salvaged during May–July.

Salvage generally is similar for the simulated Existing Condition and the Proposed Action, although, on average, salvage and resulting entrainment loss under the Proposed Action are slightly less. The impact of changes on entrainment, therefore, is considered less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

Under simulated No Action and the Proposed Action, simulated annual salvage of striped bass varies in magnitude similar to that described for the simulated Existing Condition (Figure 3.5-29b). However, a substantial increase in entrainment (i.e., greater than 40%) occurs in 1961. As explained under the impact discussion for delta smelt, the increase does not represent changes in SWP pumping that would be expected with actual implementation of the Proposed Action. As described previously for the simulated Existing Condition, the impact of increased entrainment losses on striped bass is determined to be less than significant. No mitigation is required.

Impact Fish-32: Operations-Related Reduction in Food Availability for Striped Bass

Modeled Existing Condition (2001 LOD) Comparison

The impact mechanism for operations-related reduction in food availability for striped bass is the same as that previously discussed for delta smelt. For reasons similar to those discussed for delta smelt, the impact is considered to be less than significant. No mitigation is required.

Modeled No Action (2020 LOD) Comparison

The impact is the same as described above for the simulated Existing Condition. The impact is considered to be less than significant. No mitigation is required.

3.5.4 Cumulative Impacts

In the future, Delta environmental conditions are expected to change as a result of implementation of projects and actions by Reclamation and others. Some of these future activities may harm aquatic life and habitat necessary to sustain the fish species, while others are intended to improve environmental conditions. The comparison of simulated hydrology for the Proposed Action and simulated No Action in the previous section provides an indication of future changes that were included in the CALSIM II modeling conducted for this project. This section provides a qualitative description of the effects of other projects that were not included in the CALSIM II modeling.

The CALFED Program is a collaborative effort by State and Federal agencies and stakeholders from key interest sectors created to address and resolve resource management issues in the Bay-Delta system. The CALFED ROD identifies a number of studies to be implemented to address resource management issues, including feasibility studies of major water resources projects and programs that could interact cumulatively with the Intertie project and other cumulative actions assumed and included in the CALSIM II modeling (Section 3.2, Water Supply Cumulative Impacts).

The implementing agencies are proposing to take a series of actions over the next few years that carry out or are closely related to key ROD commitments. These actions include: OCAP, SDIP, CVP–SWP Intertie (the Proposed Action), Freeport Project, and Trinity River Project. During 2003, the agencies recognized that many of their proposed actions were interrelated and that decisions on key components could not be made in isolation.

The agencies also recognized that while each had its own priorities based on jurisdiction and mandates, it was important to coordinate decision-making and move forward with a package of actions that was consistent with the Bay-Delta Program's principle of balance. The agencies have been working since 2002 to implement this balanced and integrative approach to decision-making.

Actions are being proposed in four areas: water supply, water quality, environmental protection, and science. The level of detail currently available varies, mainly because of differing project timelines, and will change over time. Some projects are in the implementation phase while others are just starting to flesh out the concepts. Not all the potential actions are agreed upon by all the CALFED agencies, and the details of others are being debated. However, there is general agreement by the agencies that these actions are worth evaluating:

- Implement SWP/CVP Integration Plan
- SDIP/Increase SWP Pumping to 8,500 cfs
- SDIP/Permanent Operable Barriers
- San Joaquin River Salinity Management Plan
- Vernalis Flow Objectives
- Old River and Rock Slough Water Quality Improvement Projects
- San Joaquin River Dissolved Oxygen TMDL
- Franks Tract Improvements

- Delta Cross Channel Program
- Through-Delta Facility Feasibility Investigation
- OCAP ESA Consultation
- SDIP ESA Consultation
- Reconsultation regarding CALFED ROD Programmatic ESA and Ecosystem Restoration Program (ERP) Commitments
- EWA
- Delta Regional Ecosystem Restoration Implementation Plan (DRERIP):

More information about the Delta improvement package (DIP) is available at the California Bay-Delta Authority Web site at:
http://www.calwater.ca.gov/DeltaImprovements/DIP/DeltaImprovementPackage.shtml

The cumulative effects of the Proposed Action in combination with implementation of other potential future projects could conceivably substantially increase the amount of water available to the CVP and SWP. Several of the projects could result in improved water quality throughout the system and particularly within the Delta, benefiting fish and other aquatic species. The projects could result in increased flows into the Delta, increased exports from the Delta for water supply purposes, and increased Delta outflows for environmental and water quality purposes. Effective application of the EWA could benefit fish and aquatic resources. However, both the direction and magnitude, based on available information, are speculative.

In addition, some of the DIP projects involve plans for extensive habitat restoration in the Delta. Other CALFED efforts would involve restoration throughout the Sacramento and San Joaquin Valleys and could improve habitat conditions for fish and other aquatic species. ERP projects may increase habitat area, reestablish riparian and floodplain function, and improve habitat quality. The program is expected to provide a beneficial contribution to cumulative impacts.

Figure 3.5-1. Comparison of Monthly Average Flow in the San Joaquin and Trinity Rivers under Existing Conditions (2001 LOD) and Proposed Action, 1922–1994 Simulation

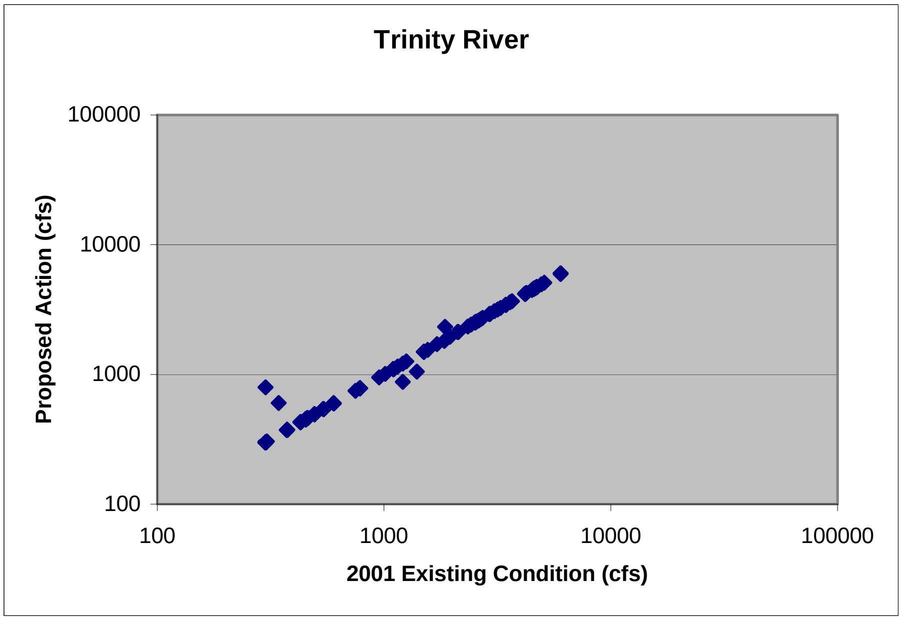
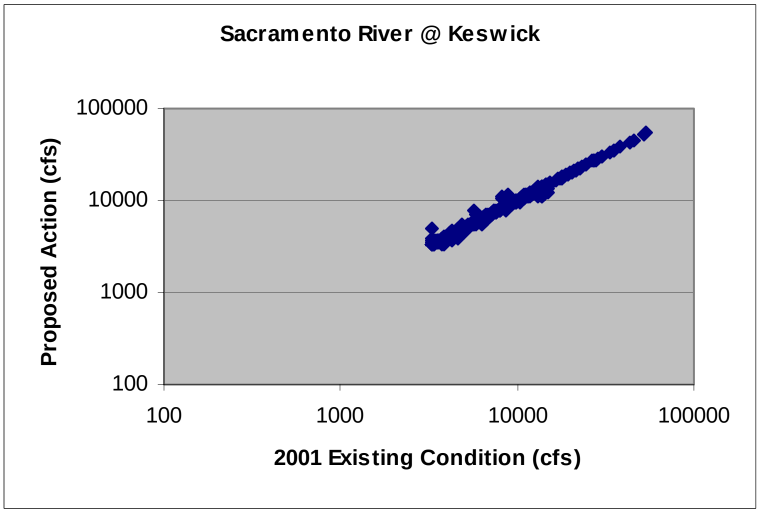
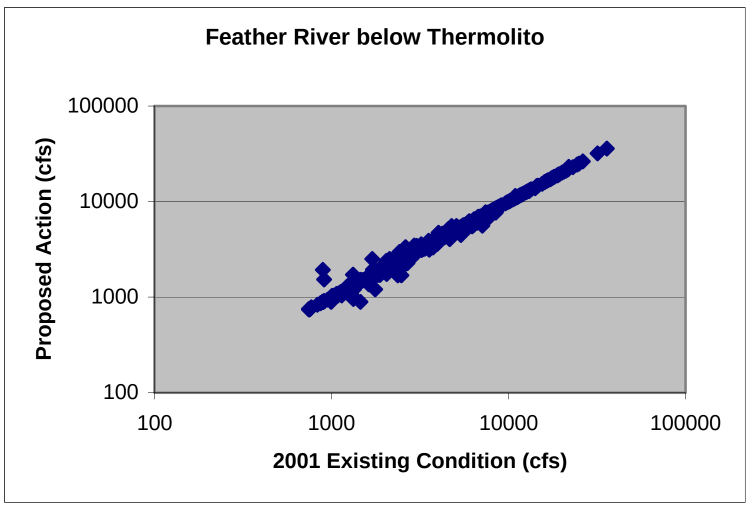


Figure 3.5-2. Comparison of Monthly Average Flow in the Sacramento, Feather, and American Rivers under Existing Condition (2001 LOD) and Proposed Action, 1922–1994 Simulation





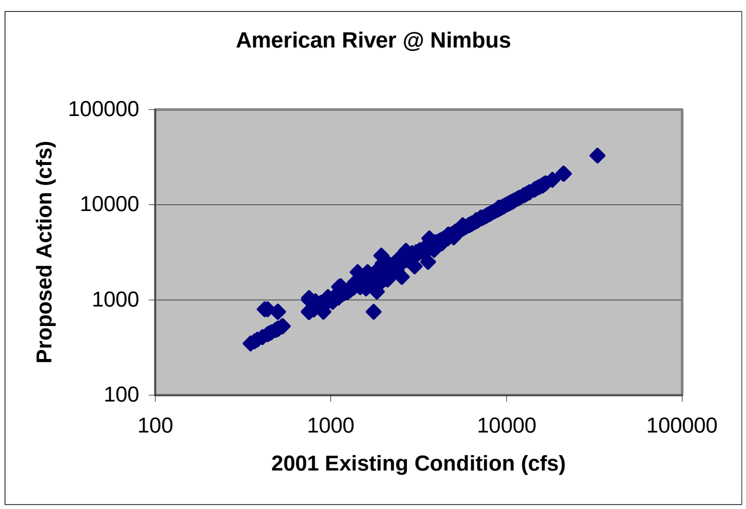
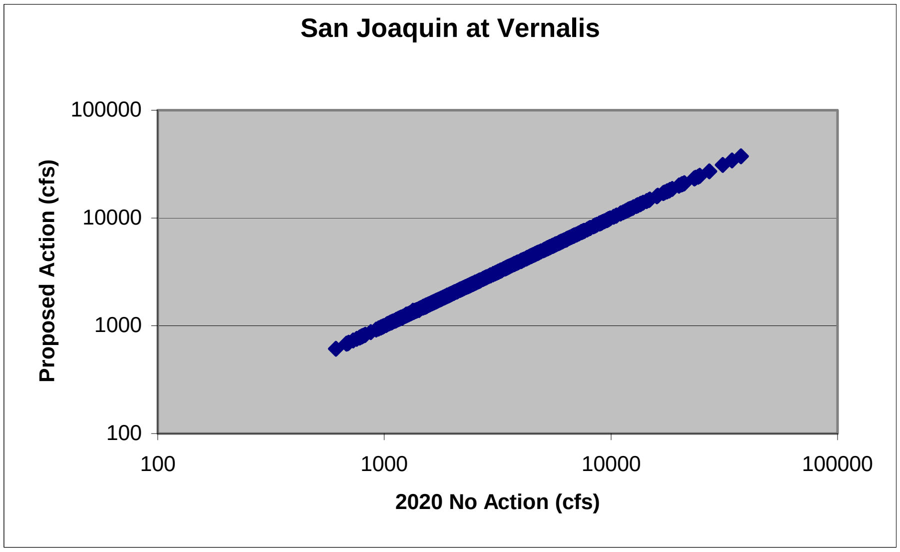


Figure 3.5-3. Comparison of Monthly Average Flow in the San Joaquin and Trinity Rivers under No Action (2020 LOD) and Proposed Action, 1922–1994 Simulation



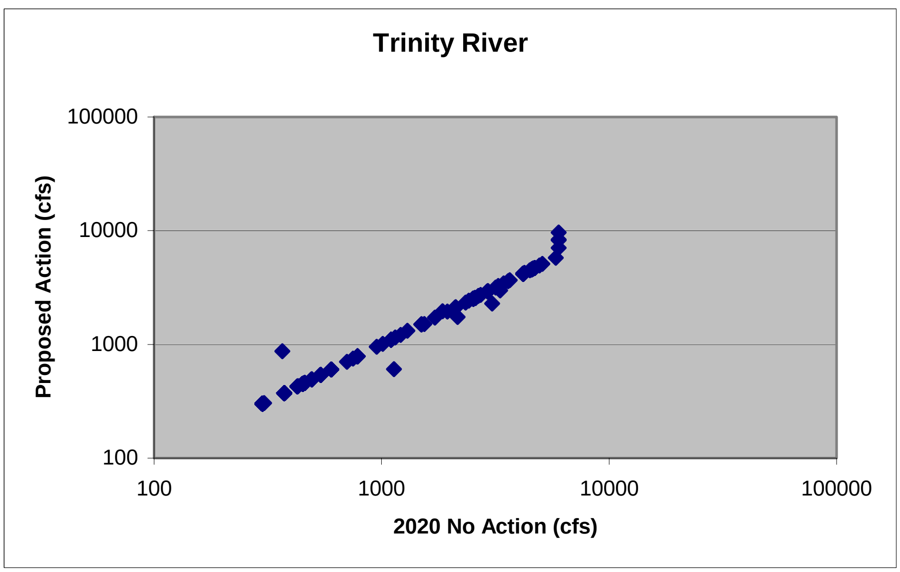


Figure 3.5-4. Comparison of Monthly Average Flow in the Sacramento, Feather, and American Rivers under the No Action (2020 LOD) and Proposed Action, 1922–1994 Simulation

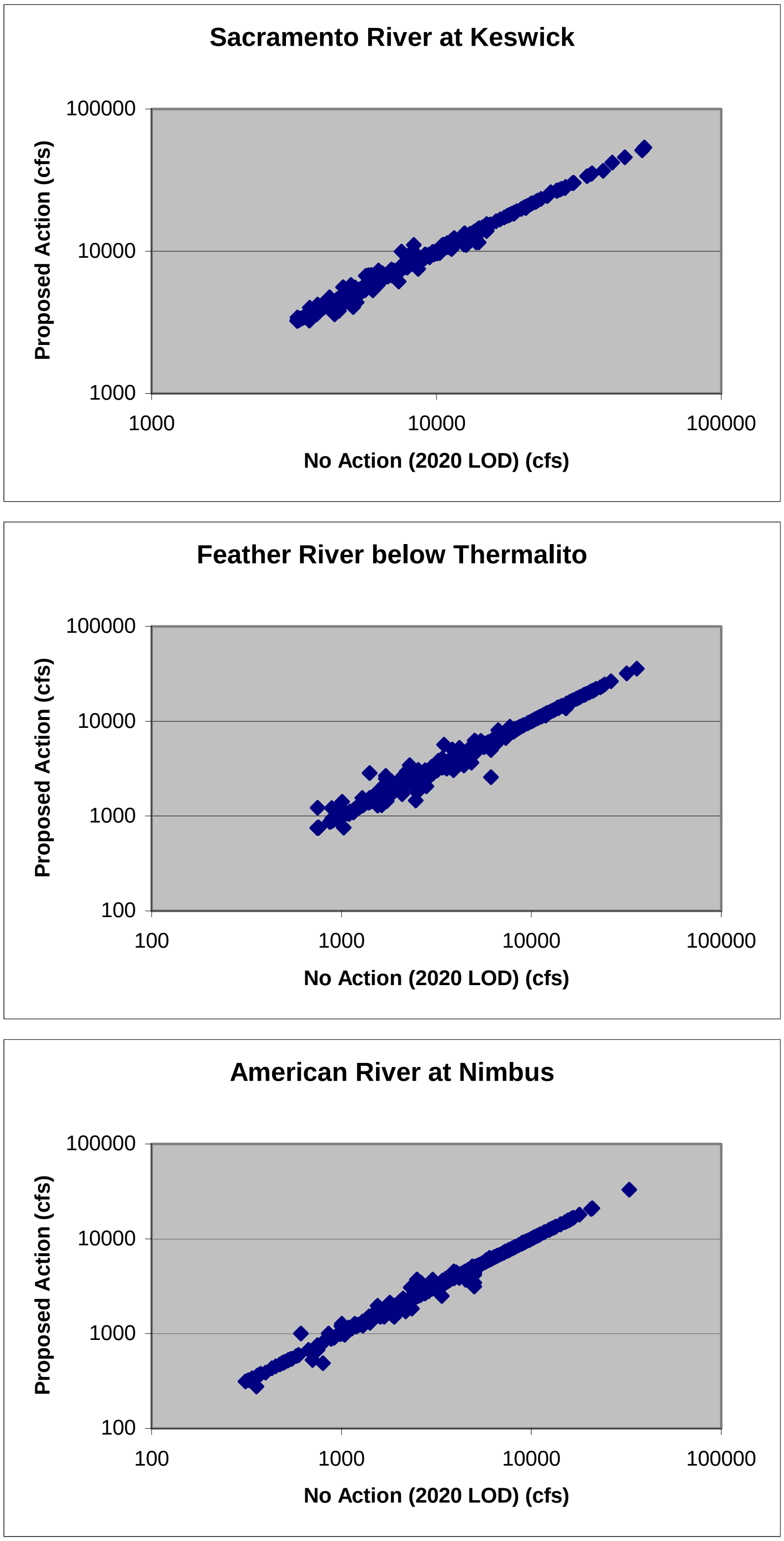
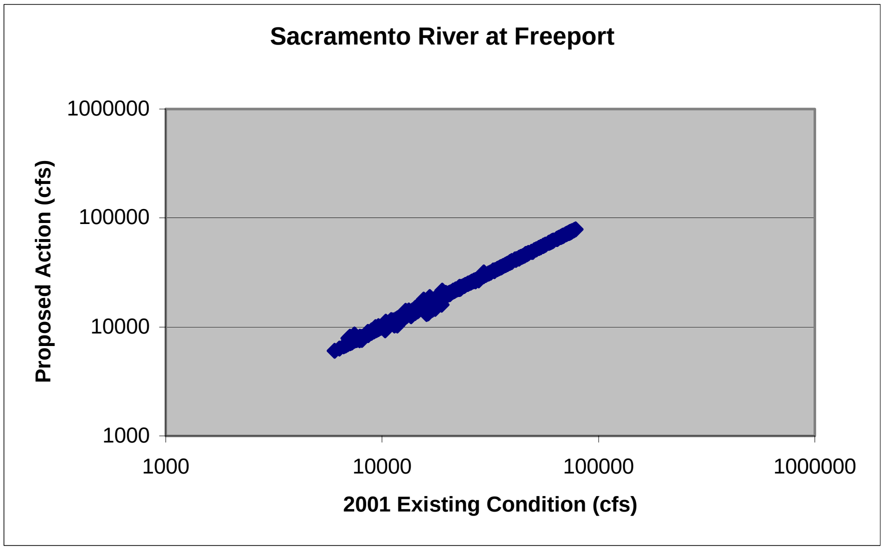


Figure 3.5-5. Comparison of Monthly Average Flow in the Sacramento River at Freeport and Monthly Average Delta Outflow under Existing Condition (2001 LOD) and the Proposed Action, 1922–1994 Simulation



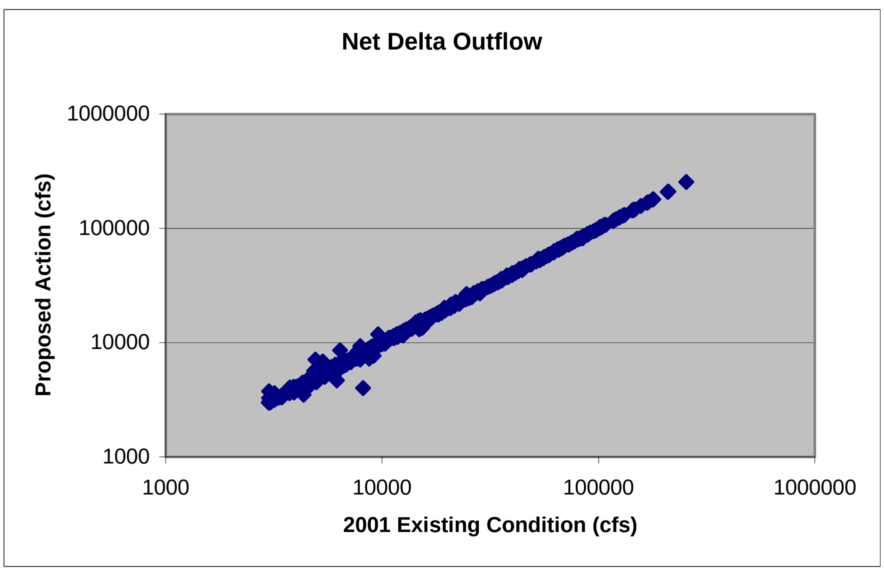
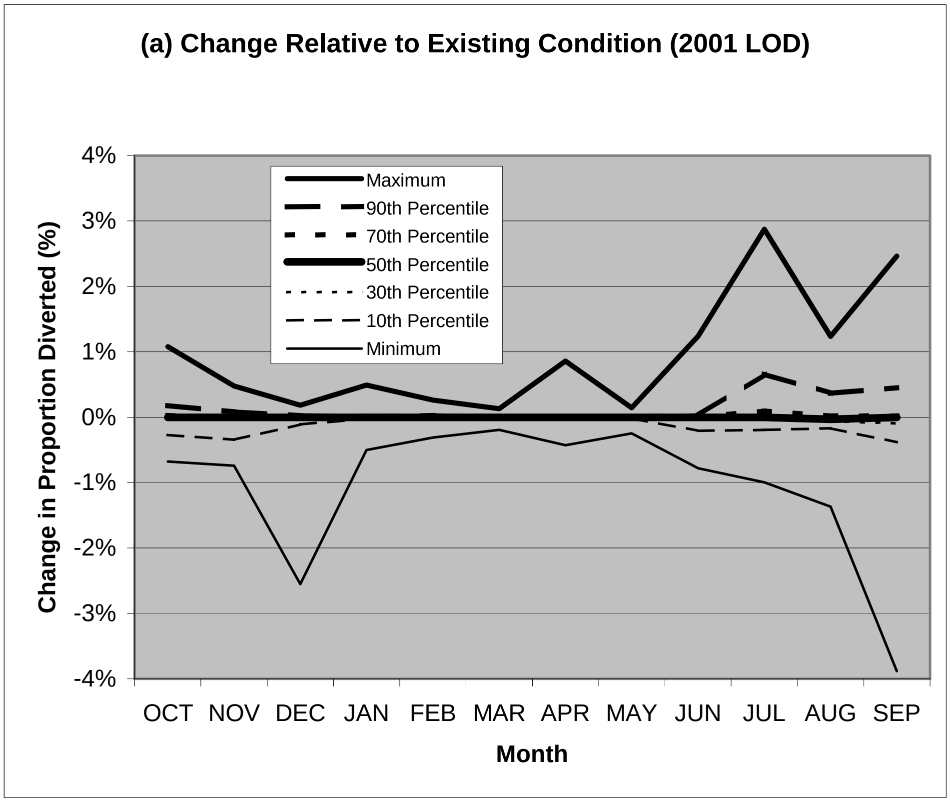


Figure 3.5-6. Change in the Proportion of Sacramento River Flow Drawn into the Delta Cross Channel and Georgiana Slough under the Proposed Action relative to (a) Existing Condition (2001 LOD) and (b) the No Action (2020 LOD), 1922–1994 Simulation



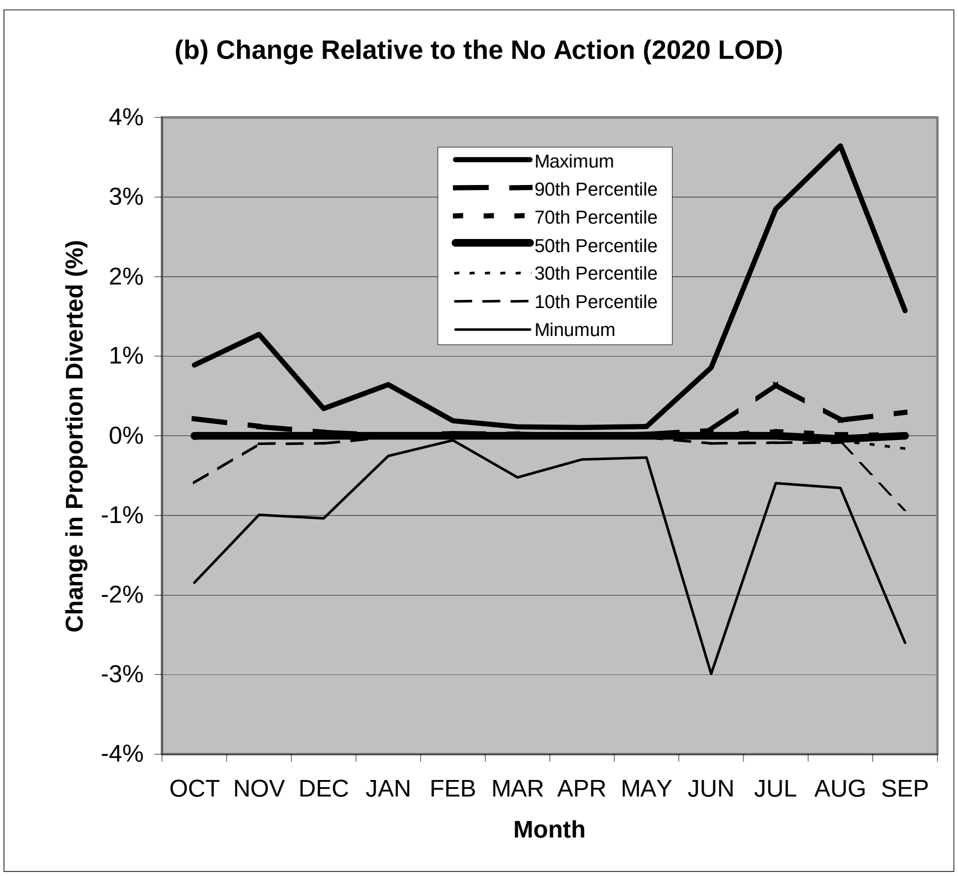
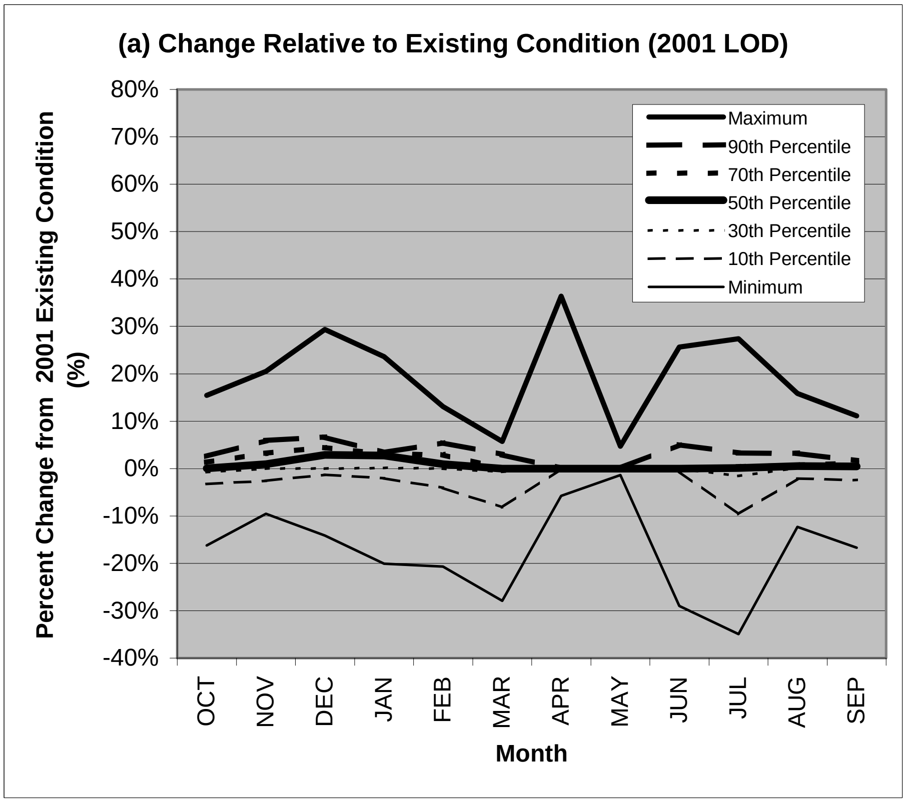


Figure 3.5-7. Change in SWP and CVP Pumping under the Proposed Action Relative to Pumping under (a) Existing Condition (2001 LOD) and (b) the No Action (2020 LOD) Condition, 1922–1994 Simulation



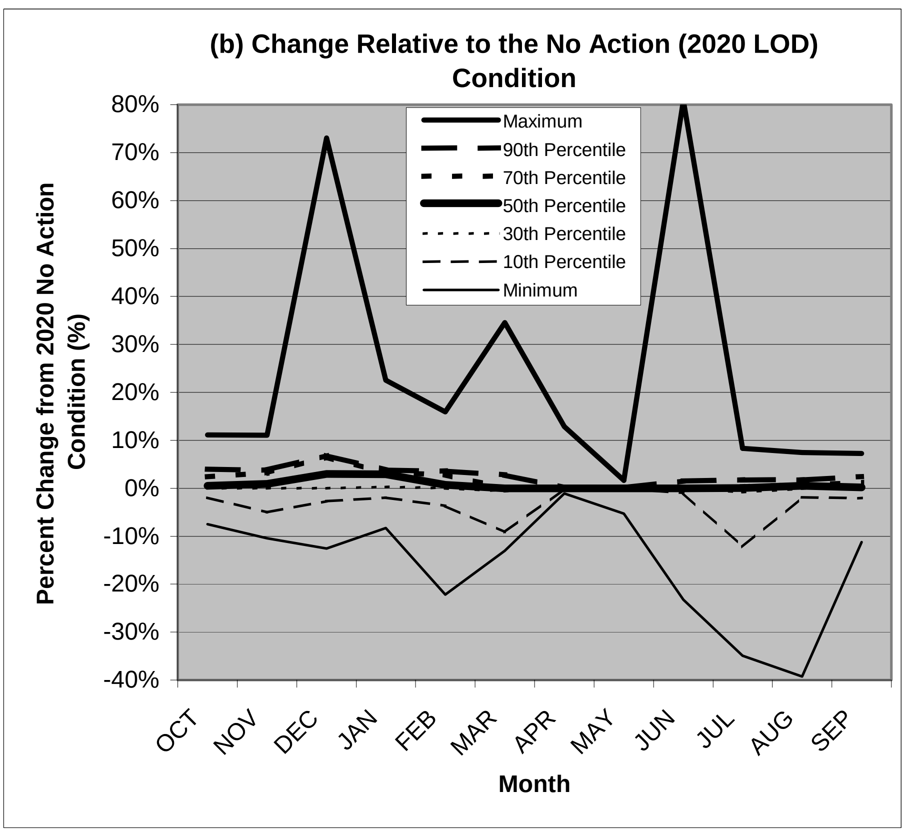
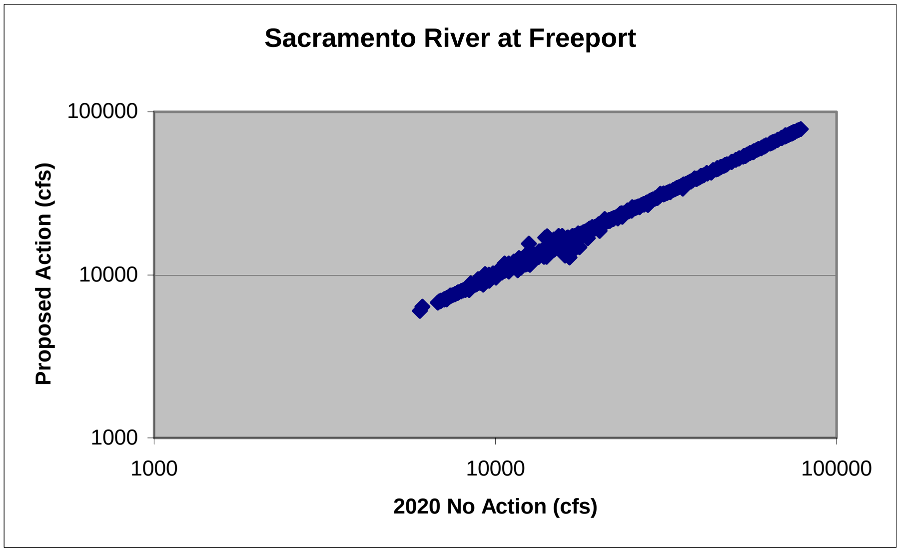


Figure 3.5-8. Comparison of Monthly Average Flow in the Sacramento River at Freeport and Monthly Average Delta Outflow under the No Action (2020 LOD) and the Proposed Action, 1922-1994 Simulation



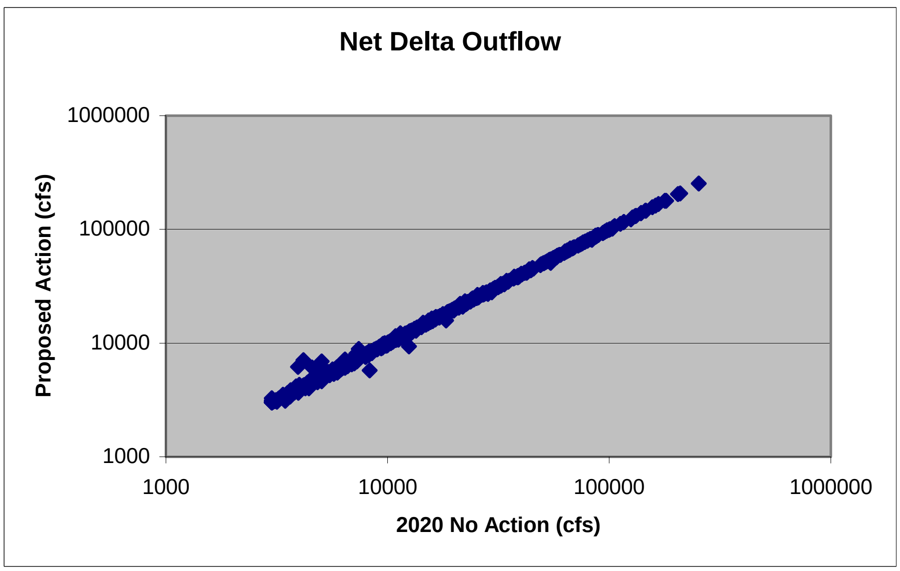


Figure 3.5-9. Comparison of Water Temperature under Proposed Action at Keswick, Bend Bridge, and Red Bluff on the Sacramento River with Water Temperature under the Existing Condition (2001 LOD), 1922–1994 Simulation

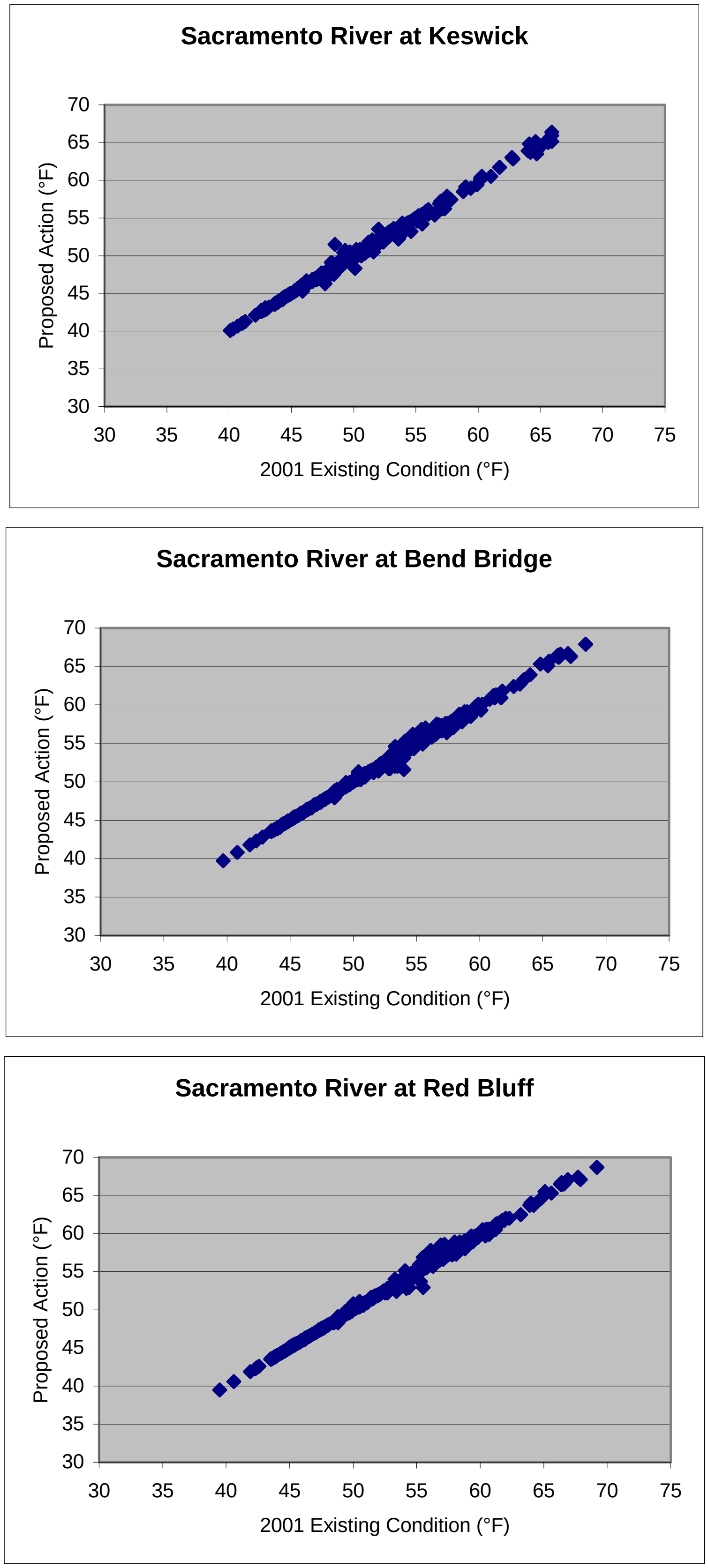


Figure 3.5-10. Comparison of Water Temperature under Proposed Action on the Feather and American Rivers with Water Temperature under Existing Condition (2001 LOD), 1922–1994 Simulation

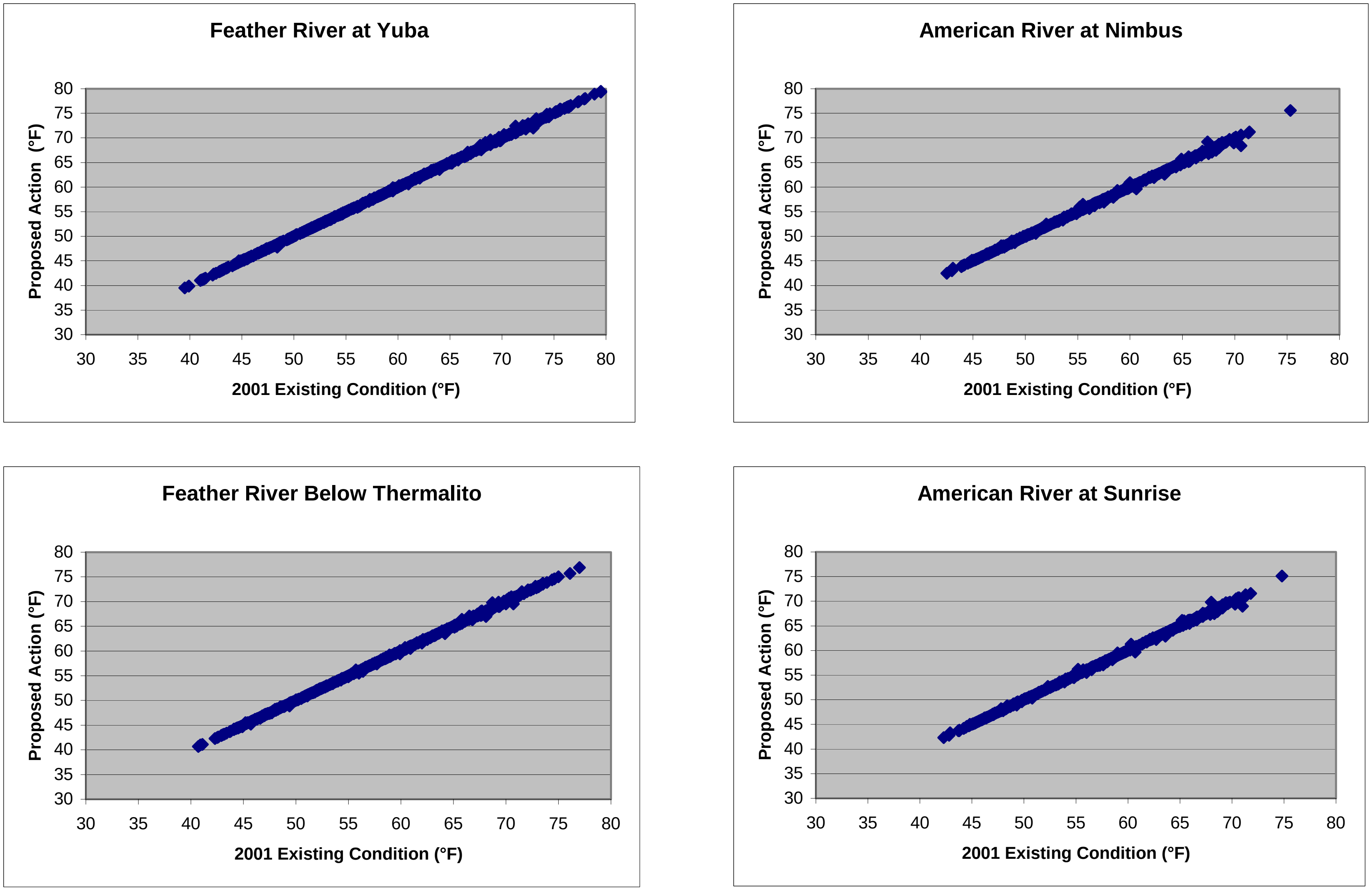
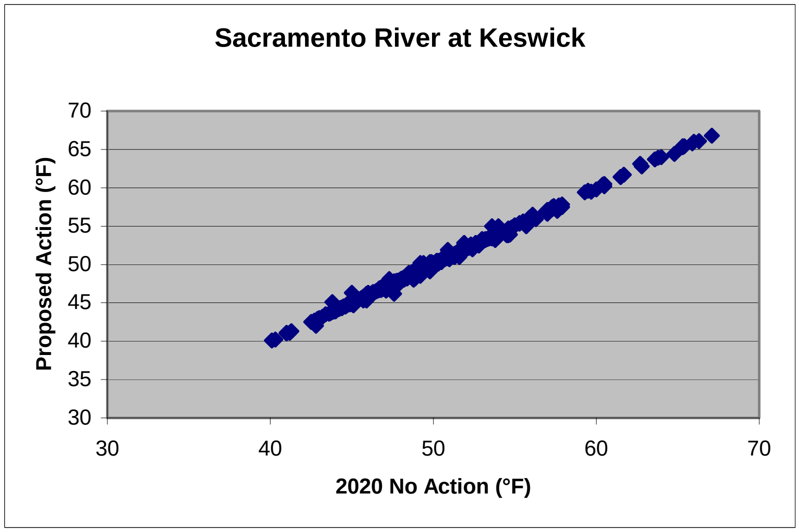
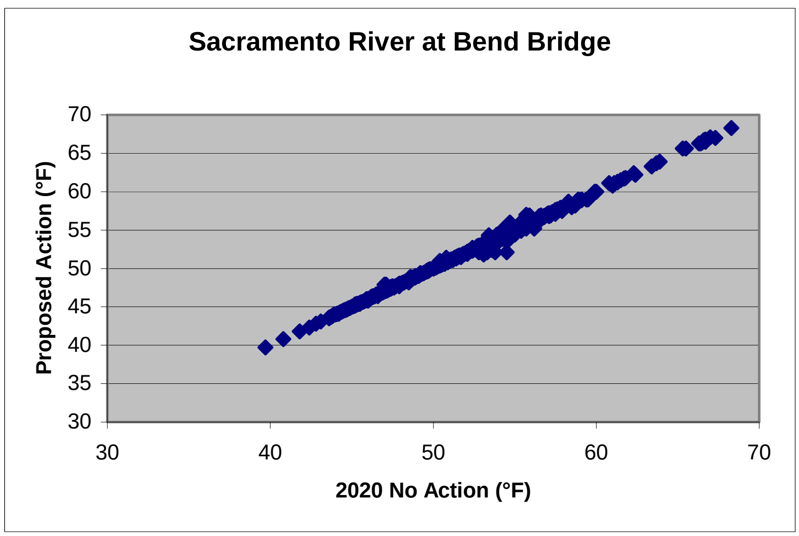


Figure 3.5-11. Comparison of Water Temperature under the Proposed Action at Keswick, Bend Bridge, and Red Bluff on the Sacramento River with Water Temperature under the No Action (2020 LOD), 1922–1994 Simulation





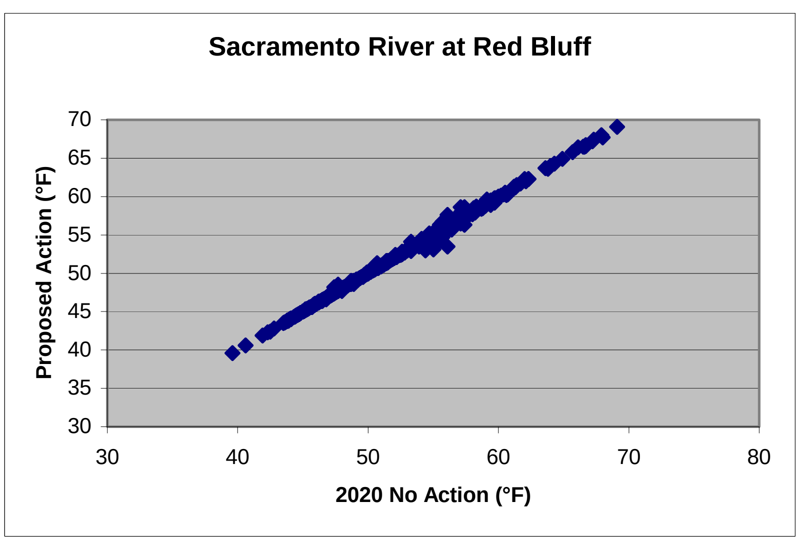


Figure 3.5-12. Comparison of Water Temperature under Proposed Action on the Feather and American Rivers with Water Temperature under the No Action (2020 LOD), 1922–1994 Simulation

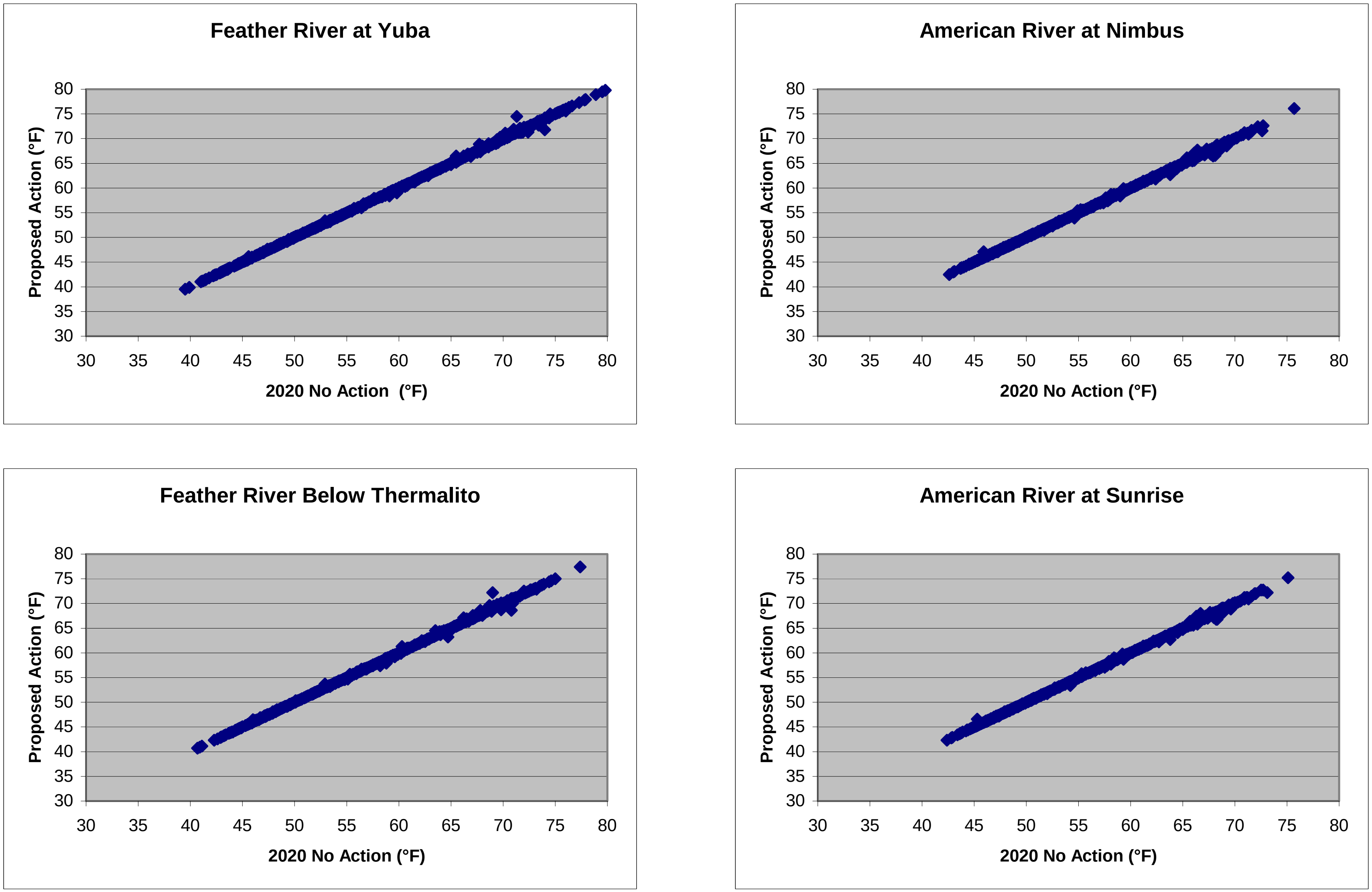
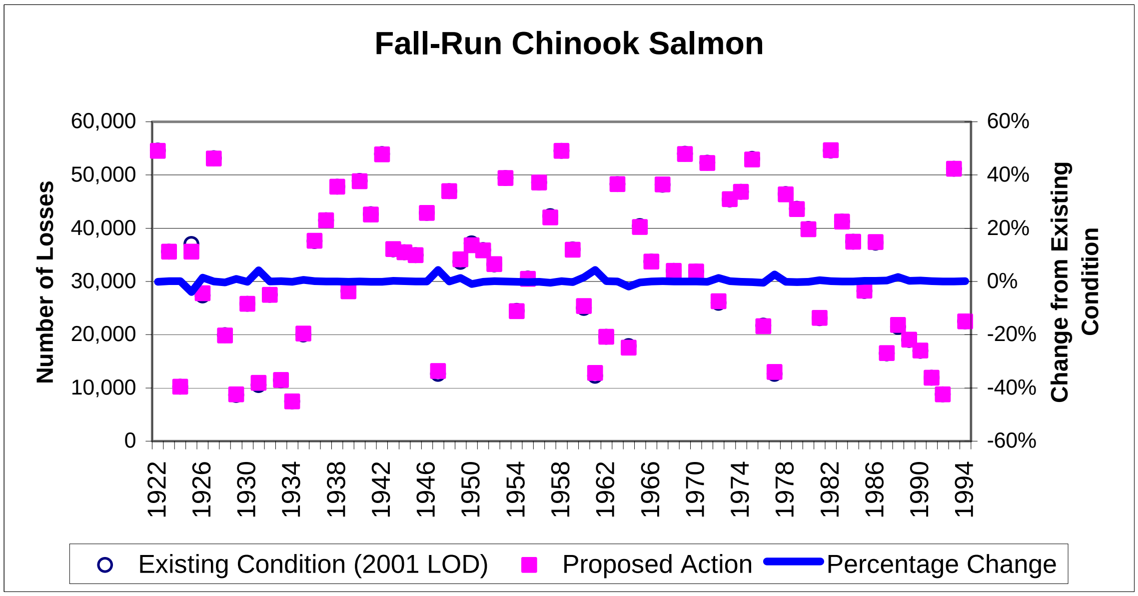


Figure 3.5-13. Simulated Entrainment Loss for Fall-, Late Fall–, Winter-, and Spring-Run Chinook Salmon under the Existing Condition (2001 LOD) and the Proposed Action, 1922–1994 Simulation



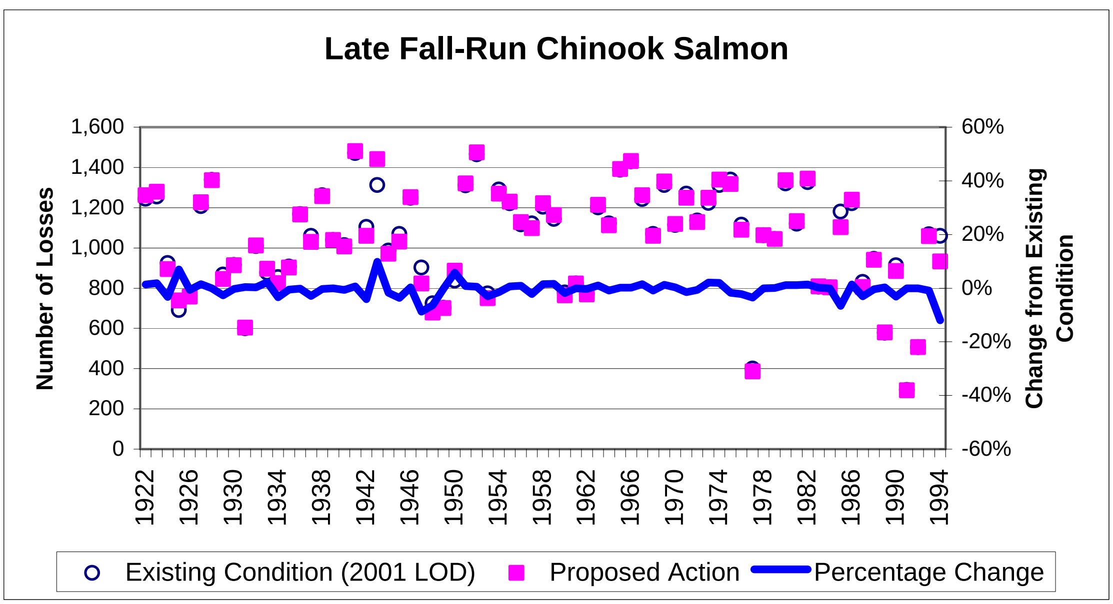


Figure 3.5-13. Simulated Entrainment Loss for Fall-, Late Fall–, Winter-, and Spring-Run Chinook Salmon under Existing Condition (2001 LOD) and the Proposed Action, 1922–1994 Simulation

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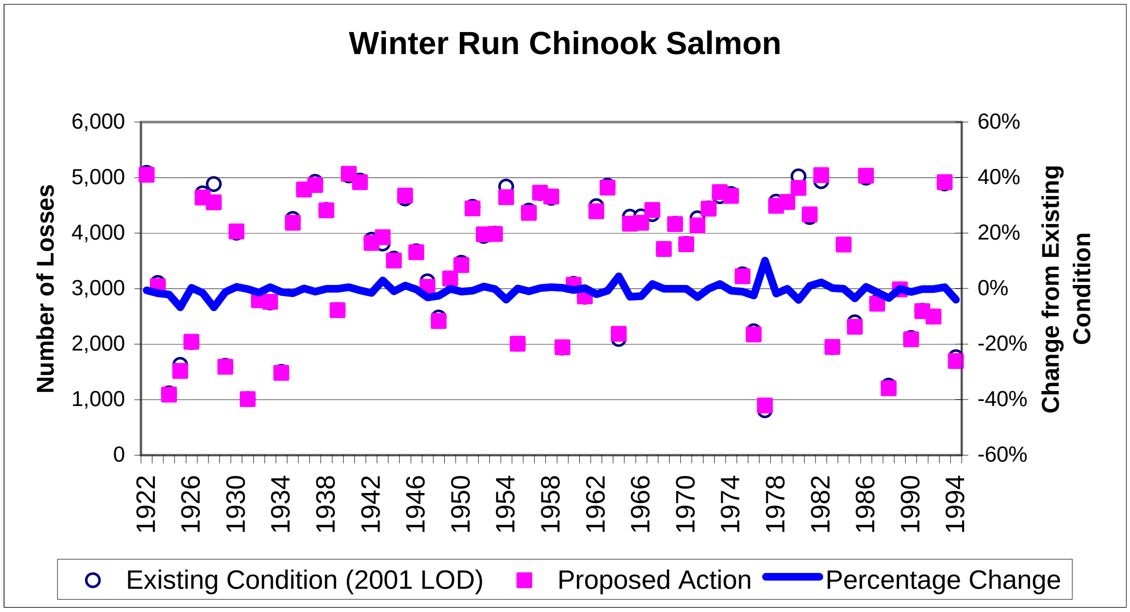


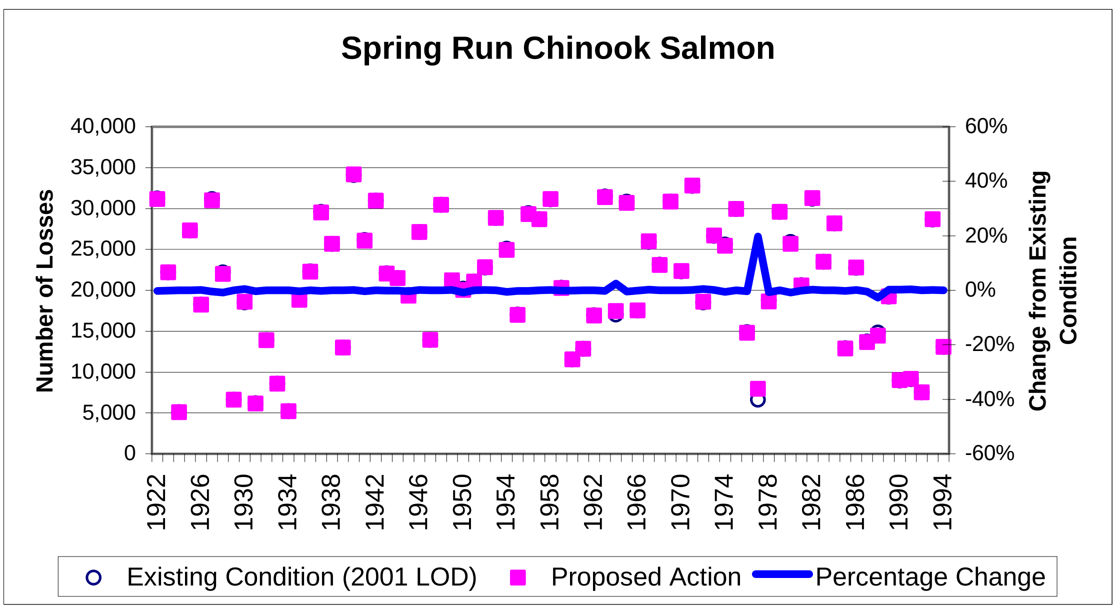
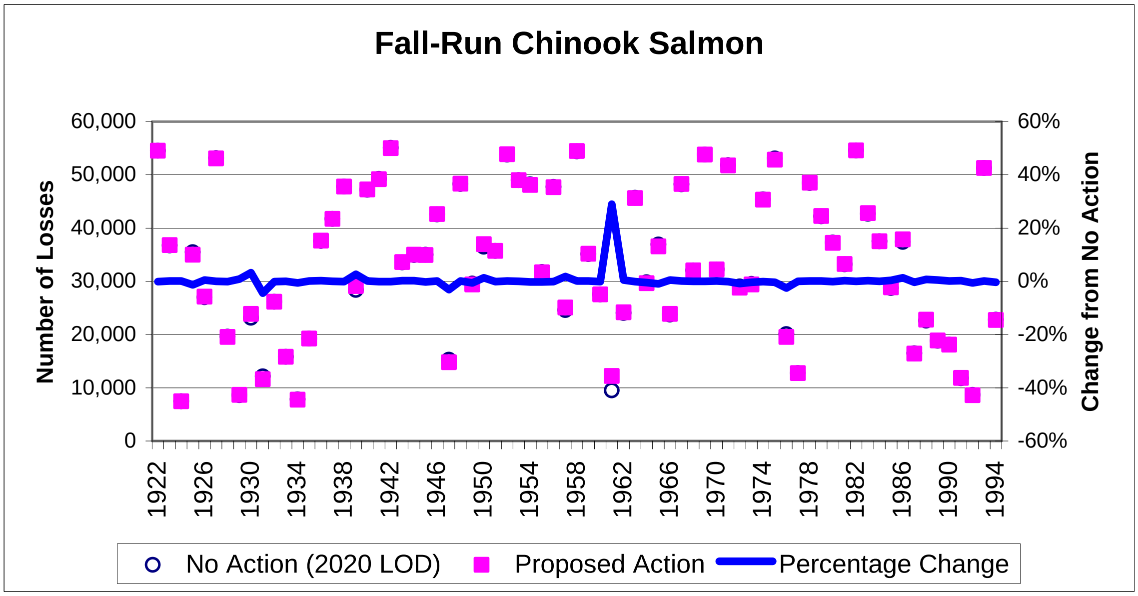


Figure 3.5-14. Simulated Entrainment Loss for Fall-, Late Fall–, Winter-, and Spring-Run Chinook Salmon under No Action (2020 LOD) and the Proposed Action, 1922–1994 Simulation



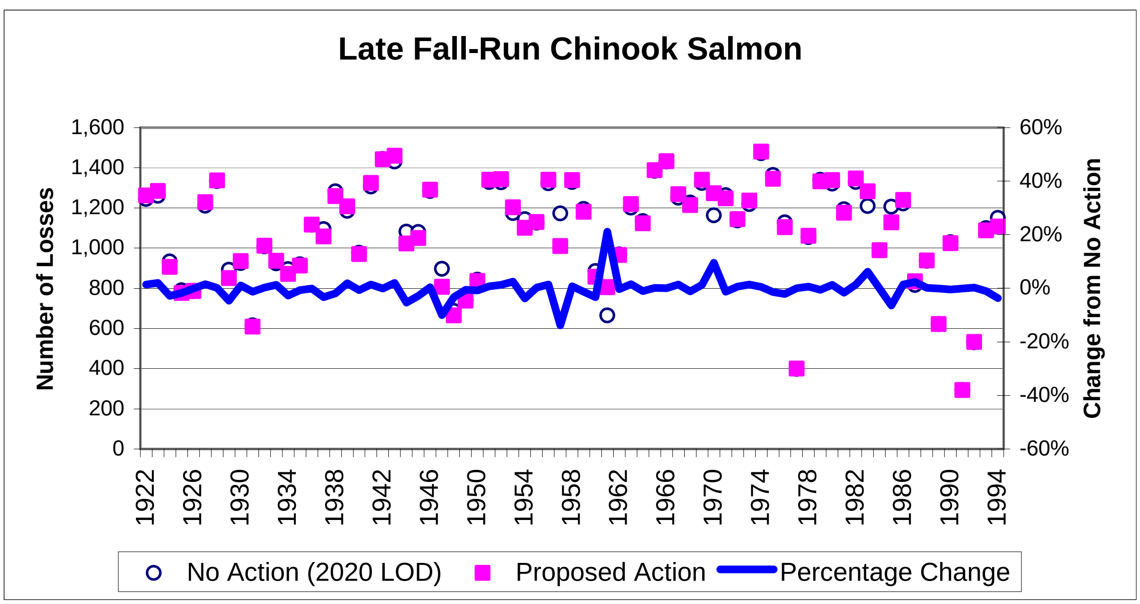
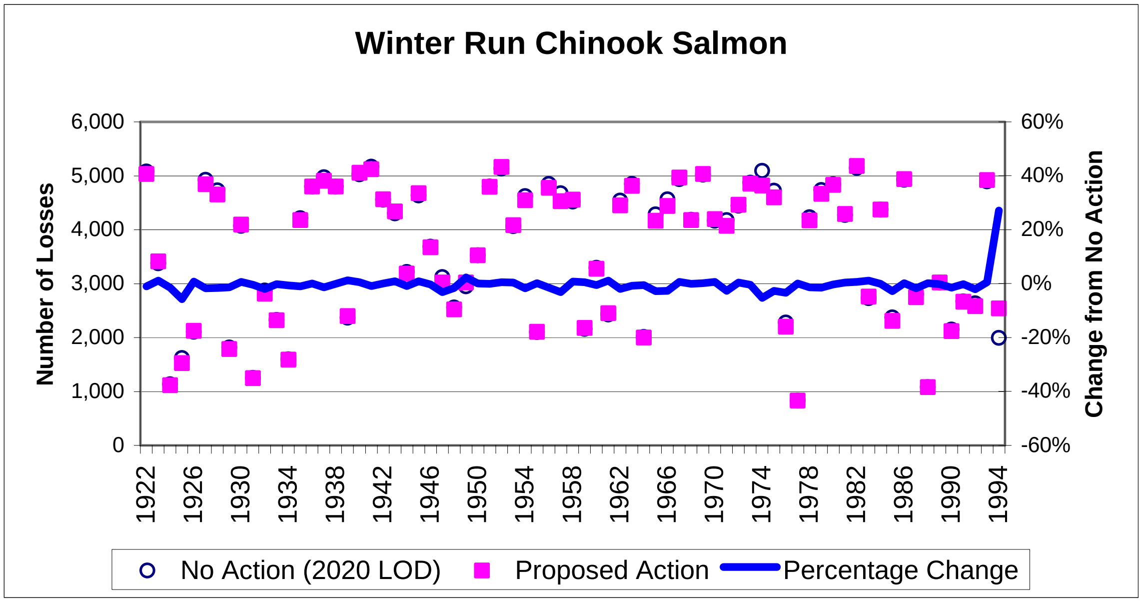


Figure 3.5-14. Simulated Entrainment Loss for Fall-, Late Fall–, Winter-, and Spring-Run Chinook Salmon under No Action (2020 LOD) and the Proposed Action, 1922–1994 Simulation



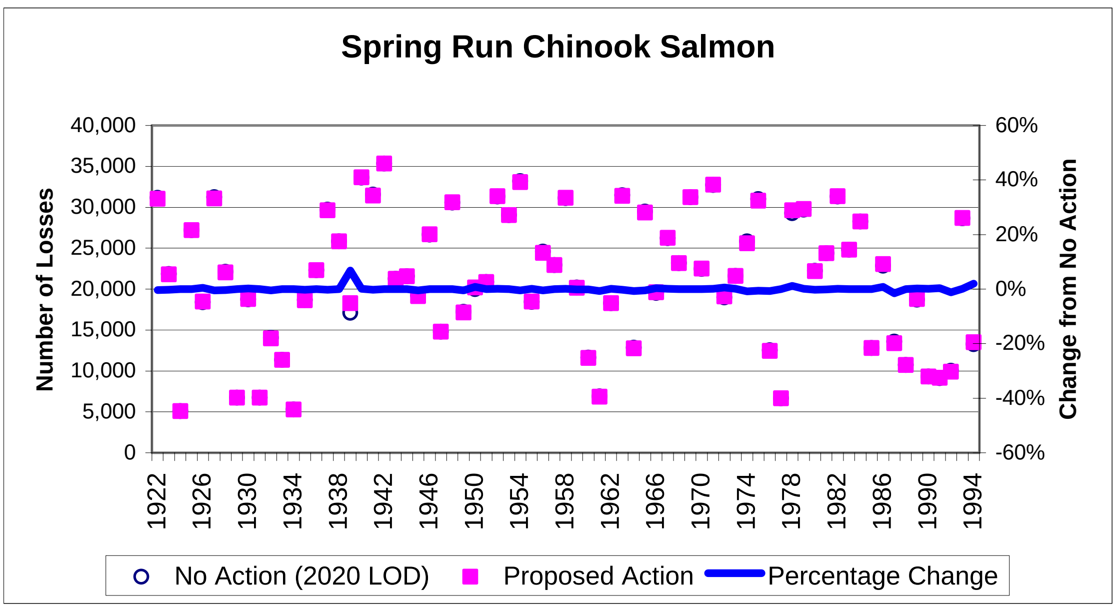
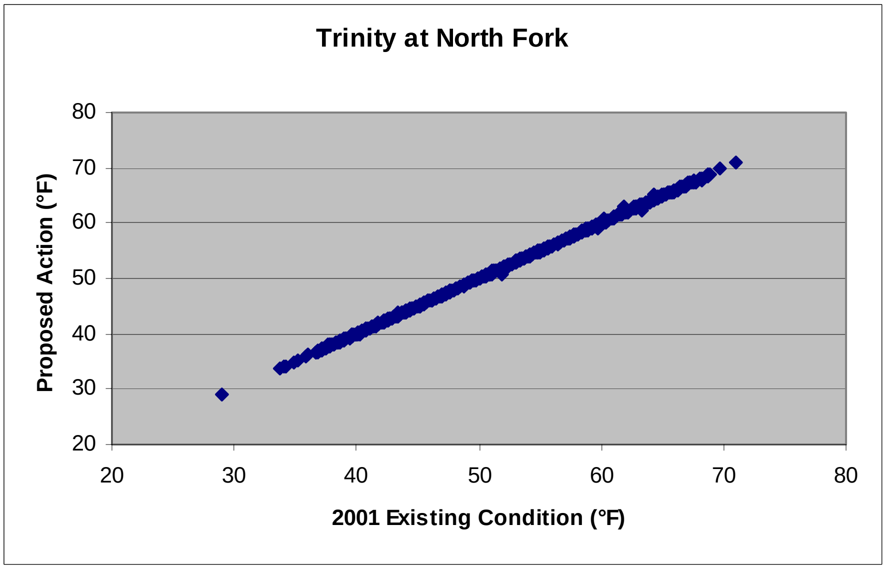


Figure 3.5-15. Comparison of Water Temperature under the Proposed Action on the Trinity River with Water Temperature under Existing Condition (2001 LOD), 1922–1994 Simulation



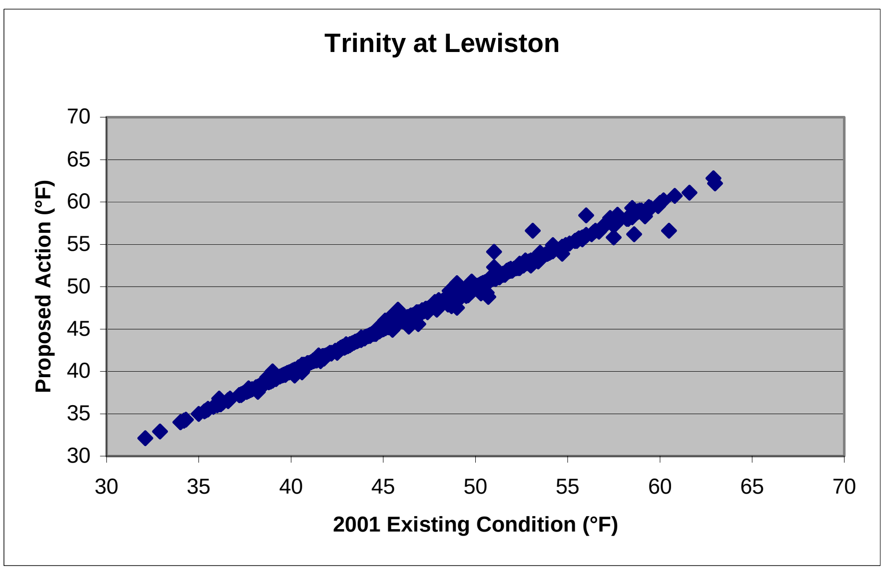
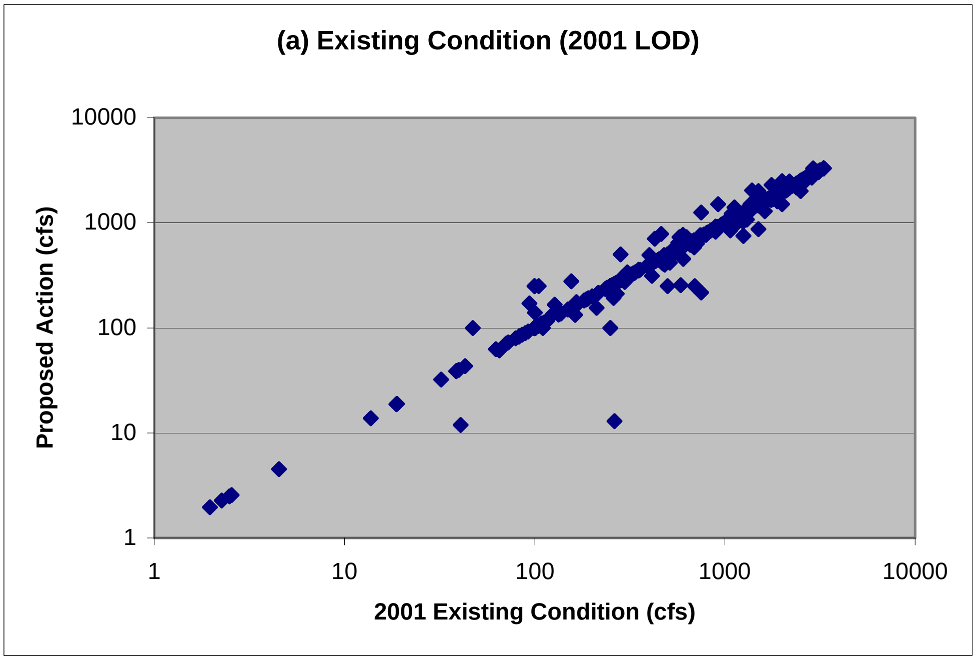


Figure 3.5-16. Comparison of Water Exports from the Trinity River to the Sacramento River under the Proposed Action with Exports under (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



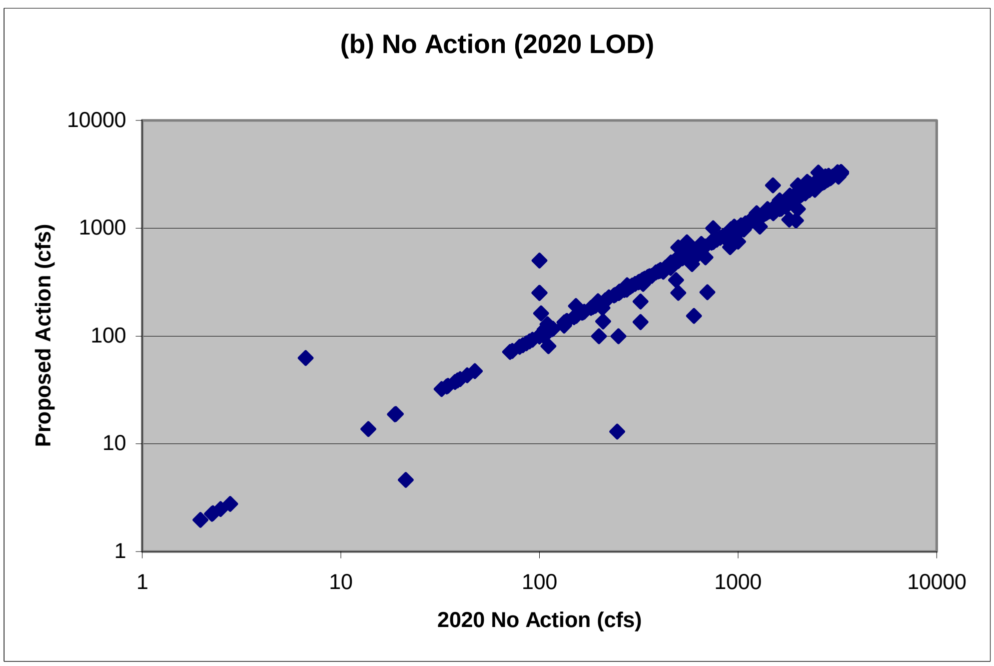
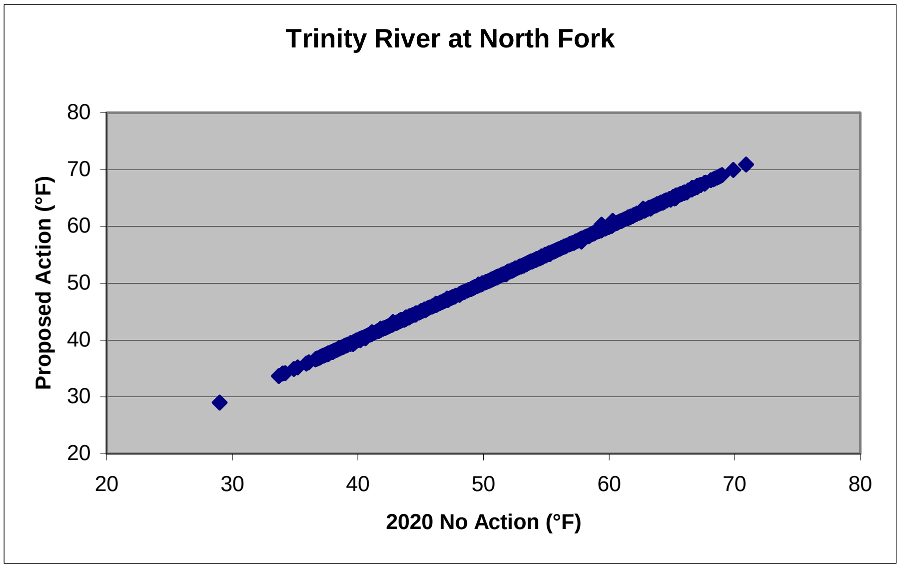


Figure 3.5-17. Comparison of Water Temperature under the Proposed Action on the Trinity River with Water Temperature under No Action (2020 LOD), 1922–1994 Simulation



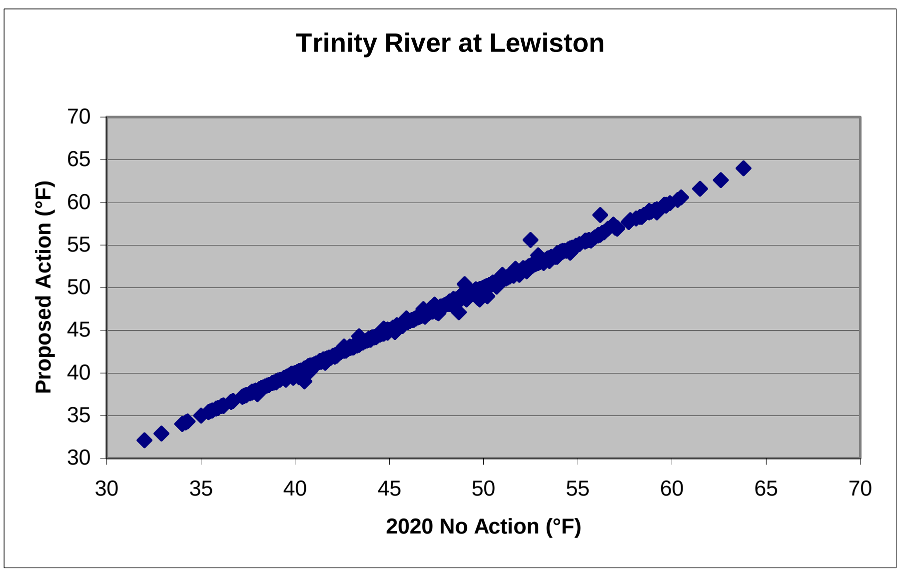
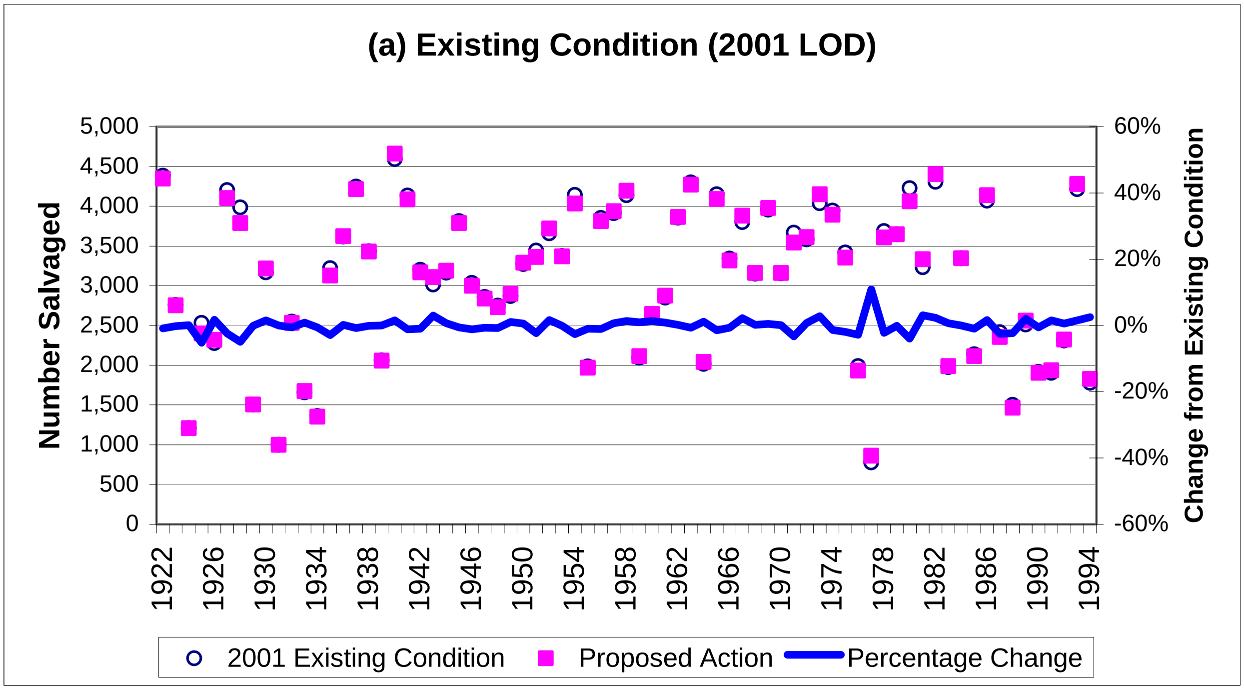


Figure 3.5-18. Simulated Salvage for Steelhead under the Proposed Action Compared Relative to (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



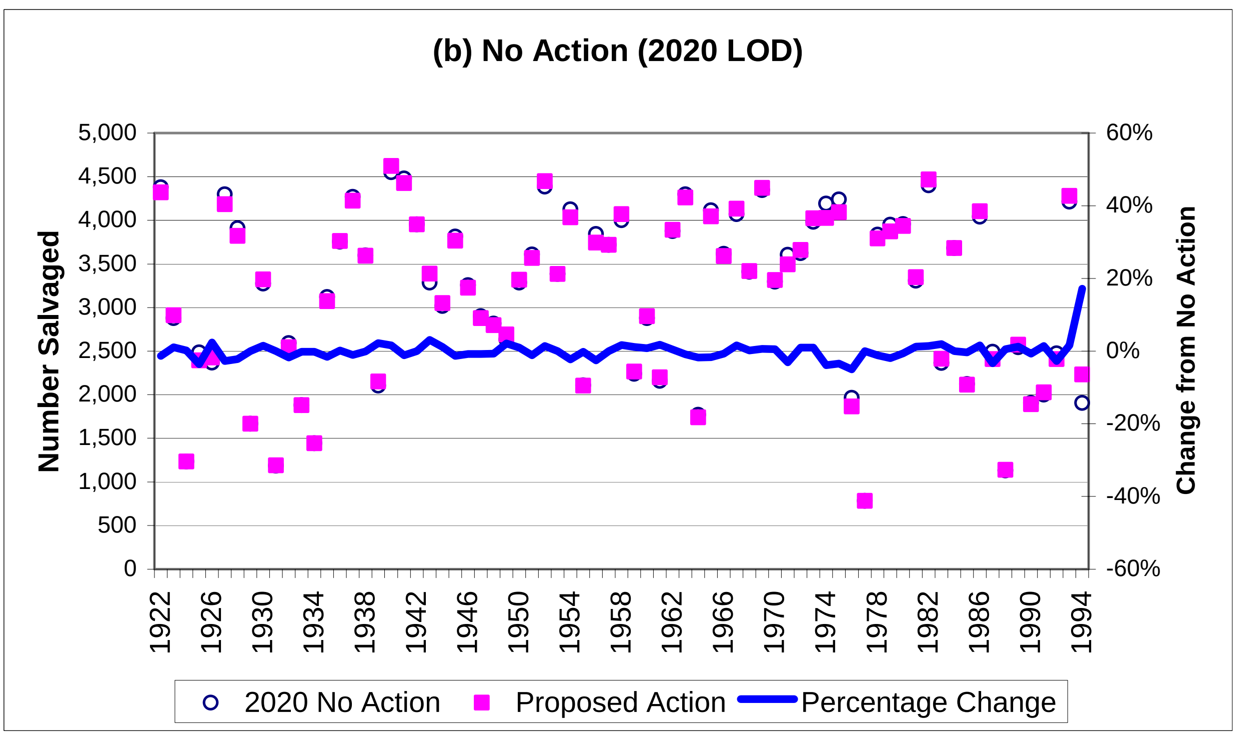


Figure 3.5-19. Change in X2 Location under the Proposed Action relative to X2 Location under (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation

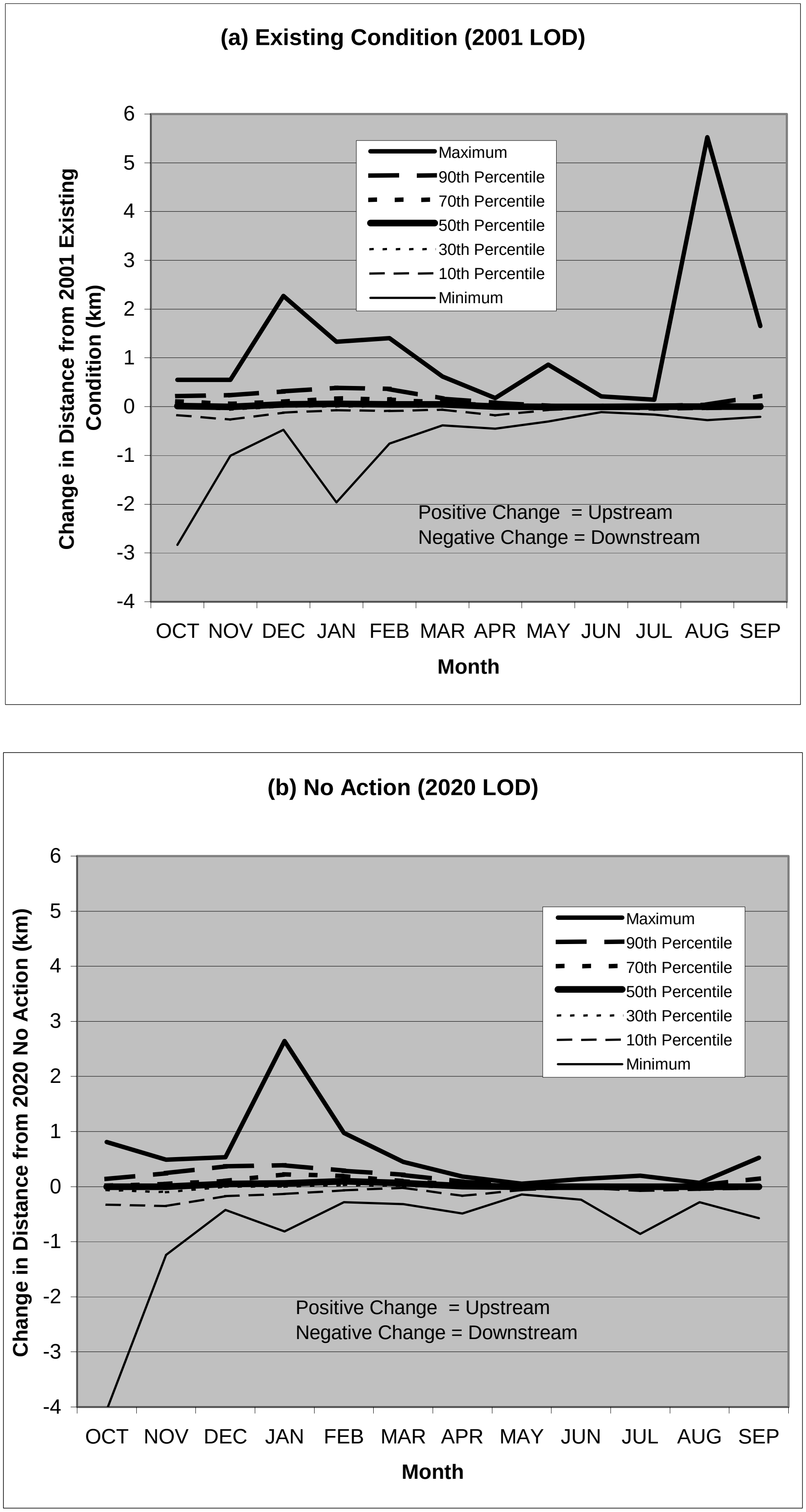
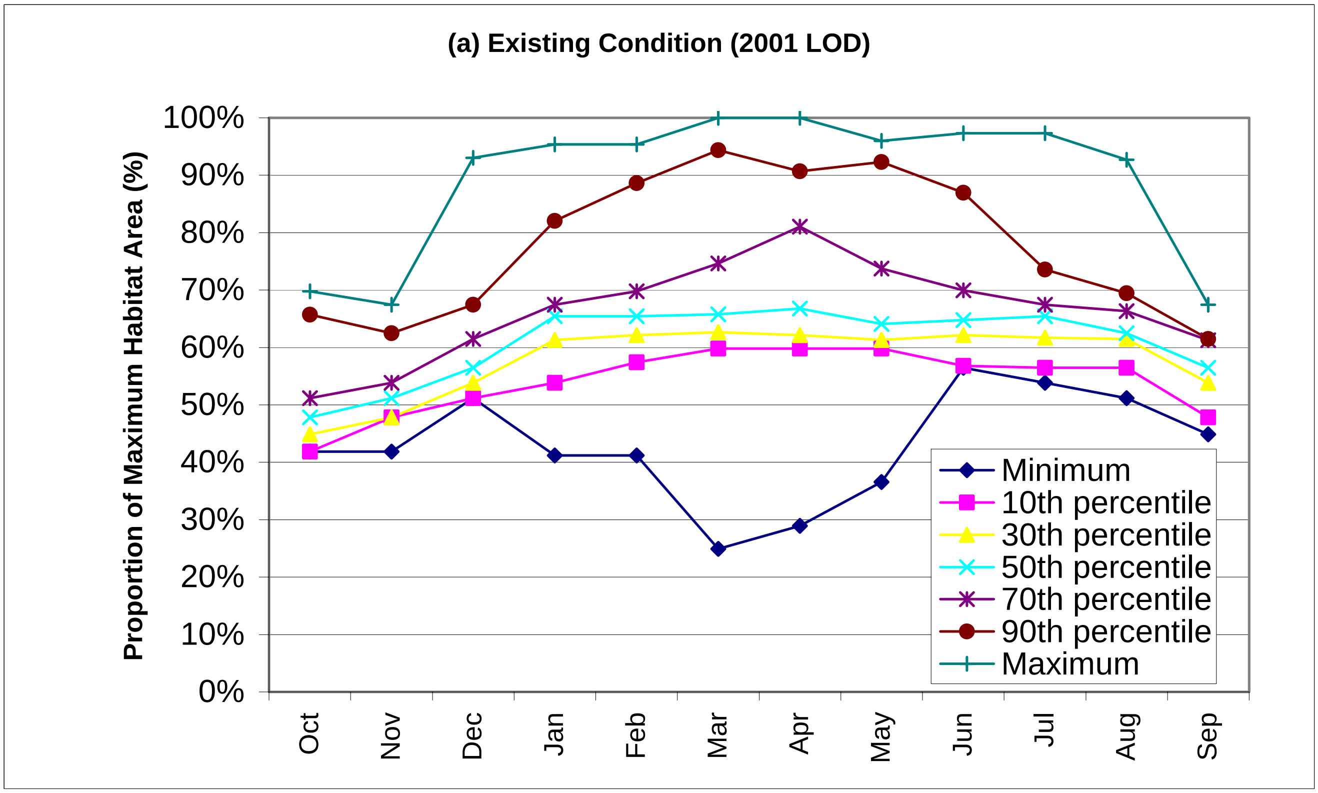


Figure 3.5-20. Occurrence of Estuarine Rearing Habitat Area (i.e., proportion of maximum area) for Delta Smelt under (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



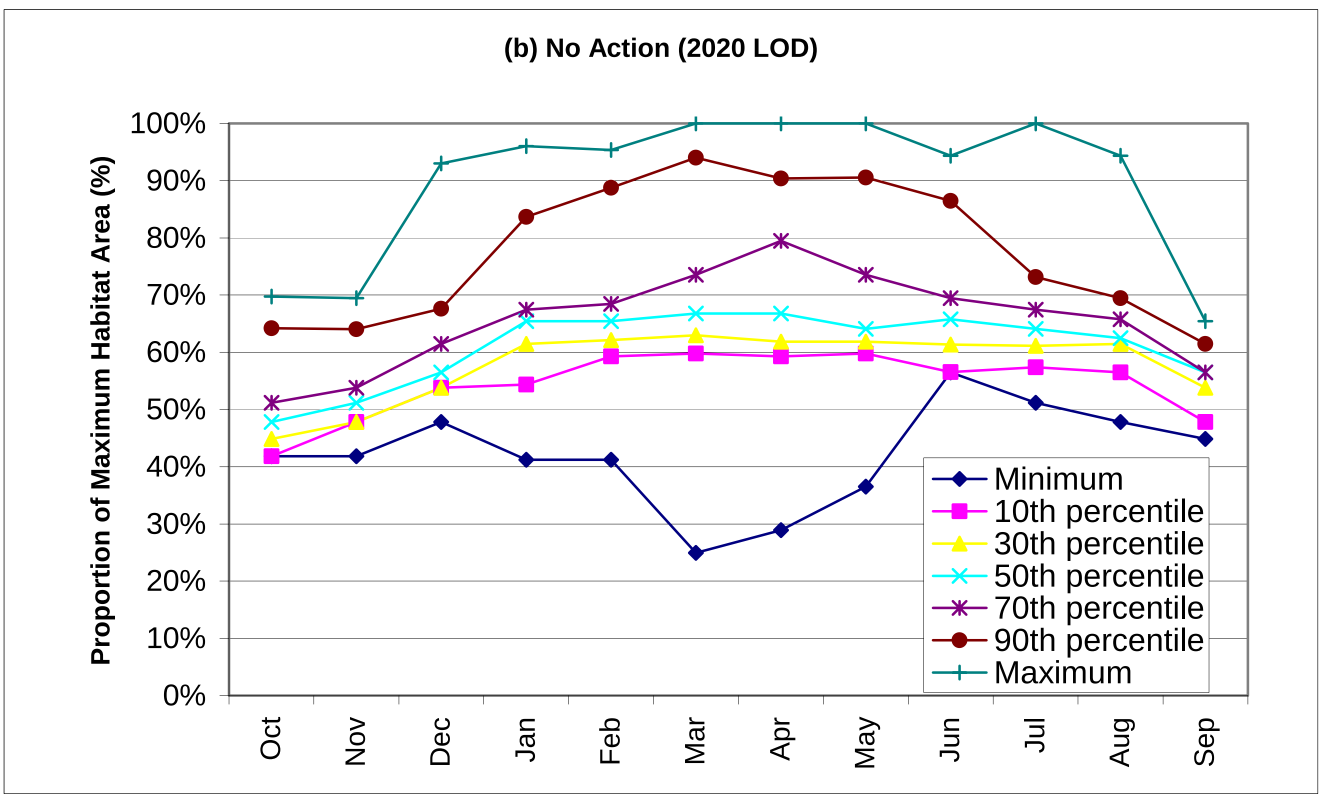
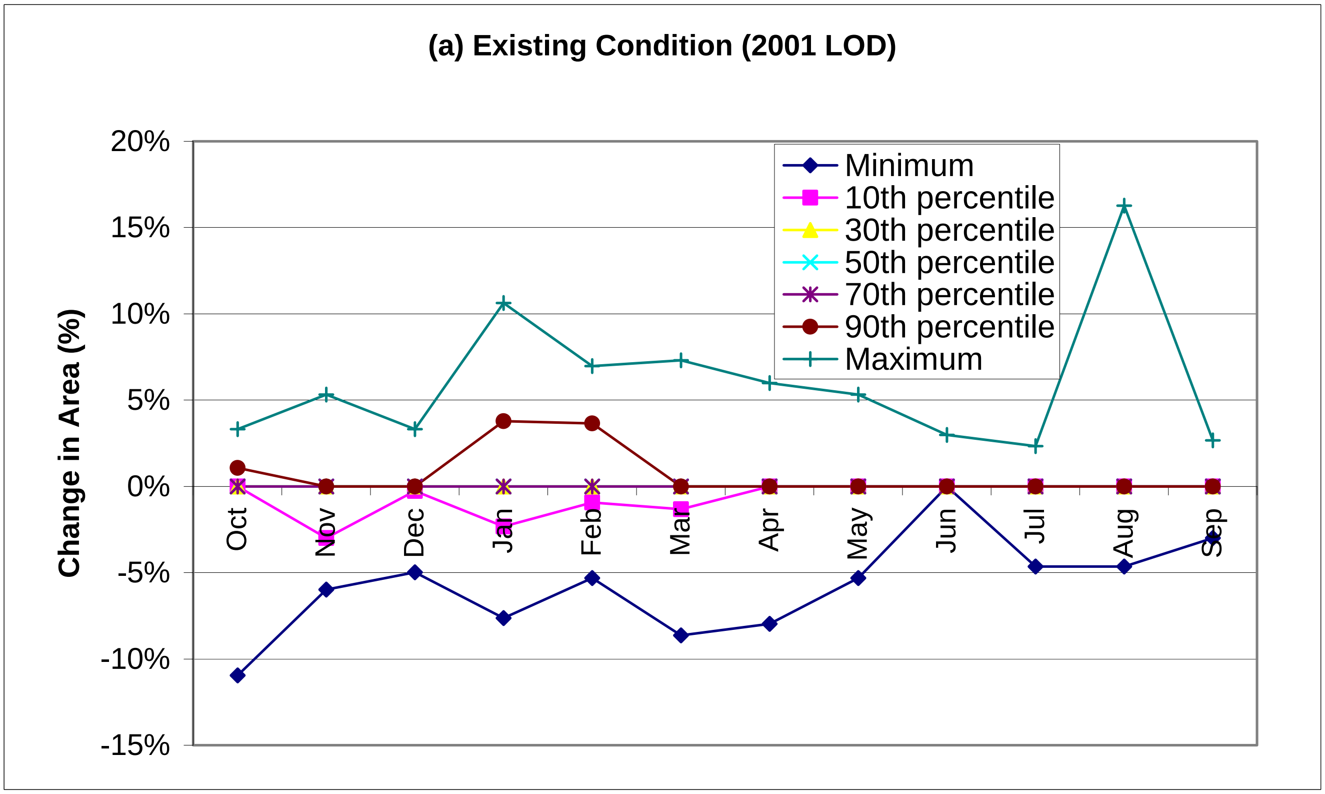


Figure 3.5-21. Change in the Proportion of Estuarine Rearing Habitat Area for Delta Smelt under the Proposed Action relative to (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



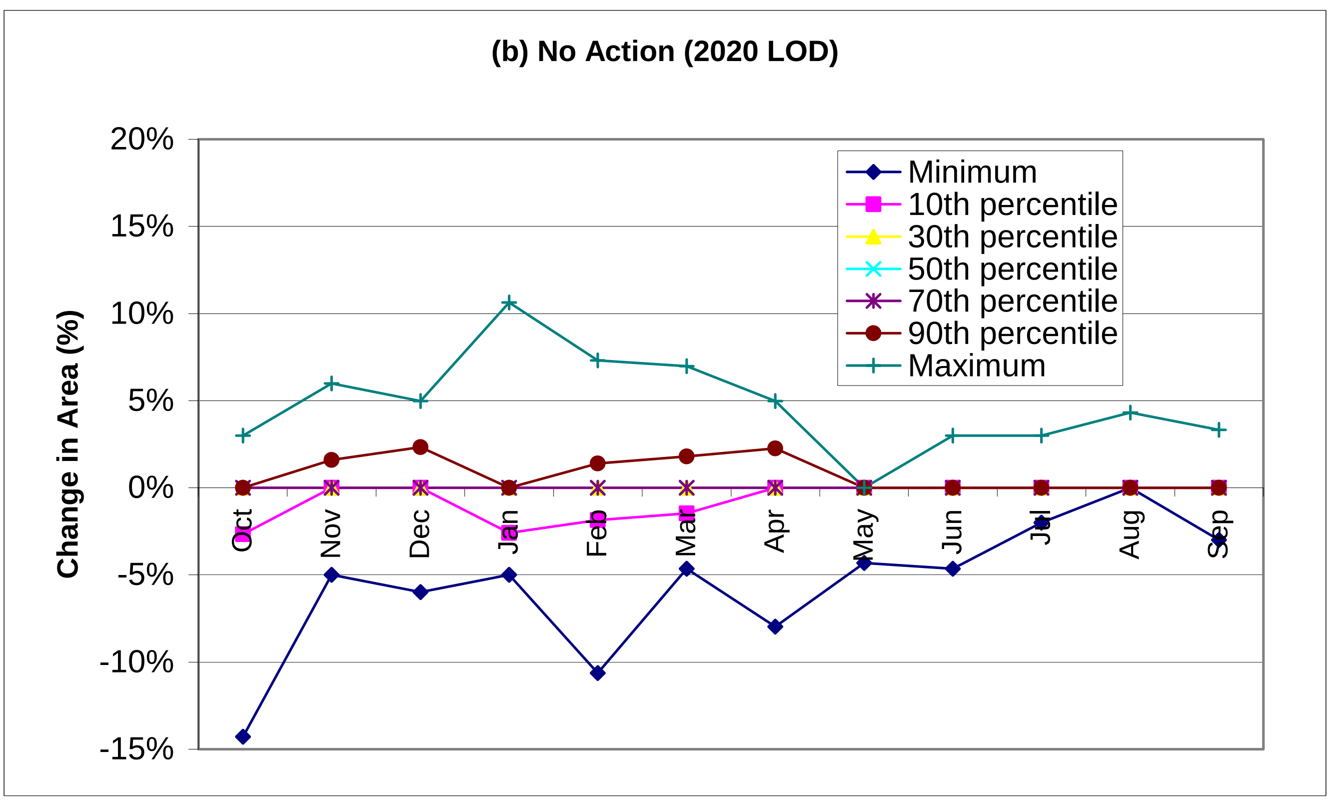
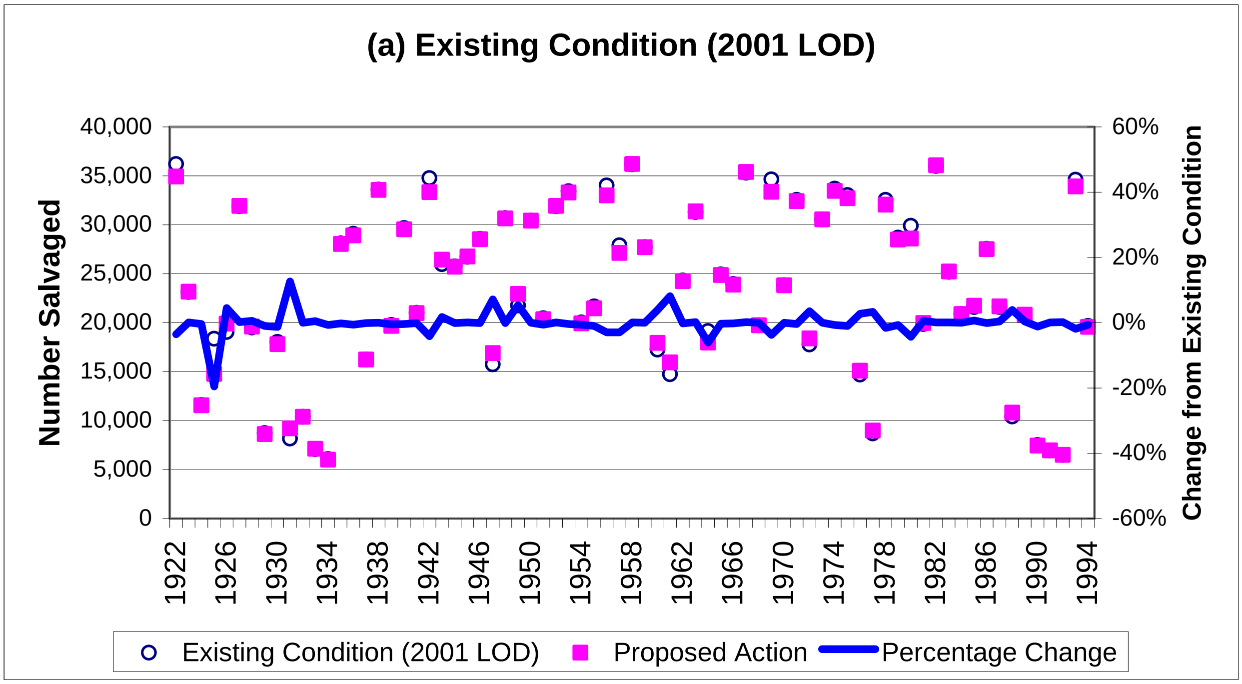


Figure 3.5-22. Simulated Salvage for Delta Smelt under the Proposed Action Relative to (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



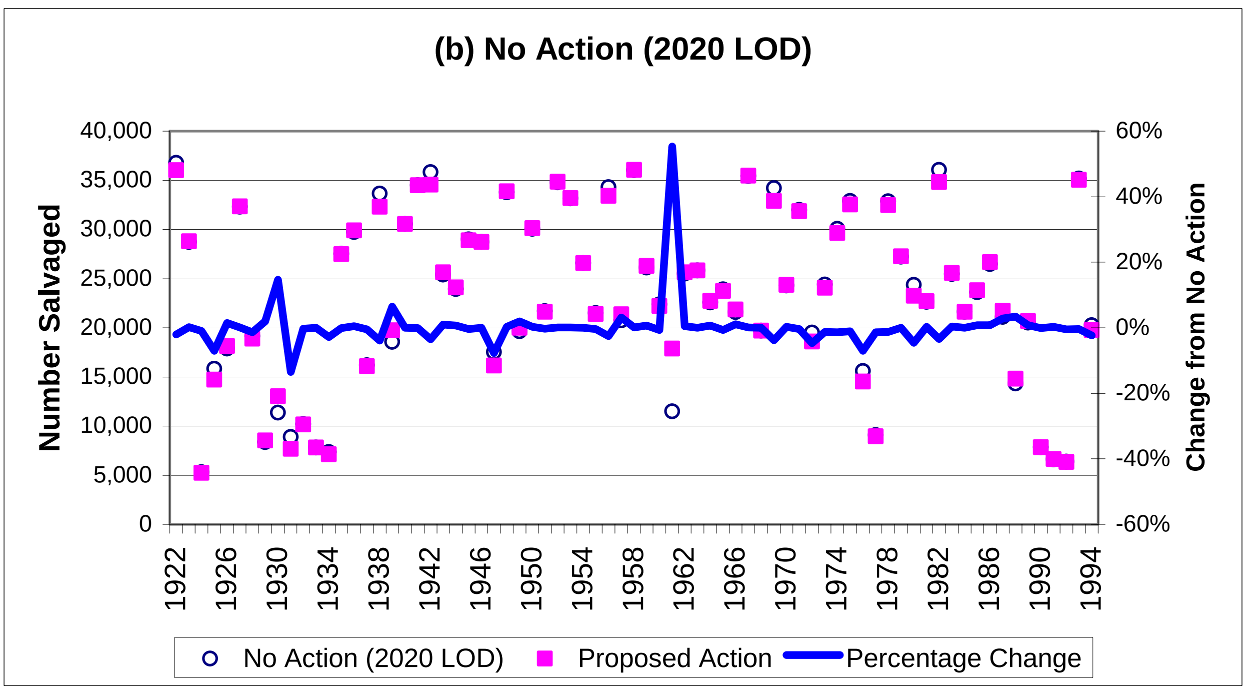


Figure 3.5-23. Annual Change in Delta Smelt Salvage for May–July and August–April Periods for the Proposed Action relative to Existing Condition (2001 LOD), 1922–1994 Simulation

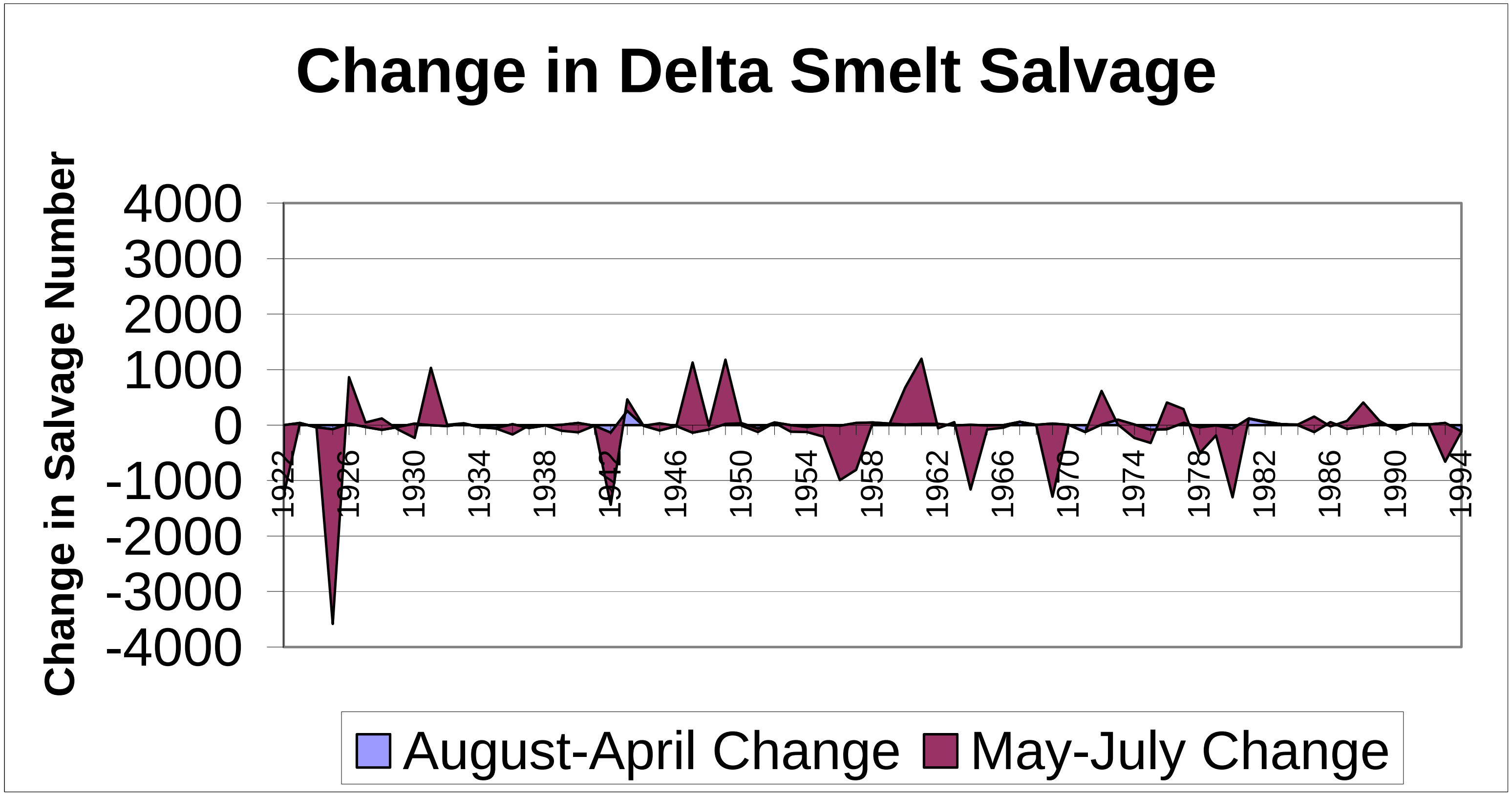


Figure 3.5-24. Monthly Median Size of Delta Smelt Salvaged at the SWP and CVP Fish Facilities, 1980–2002 Historical Data

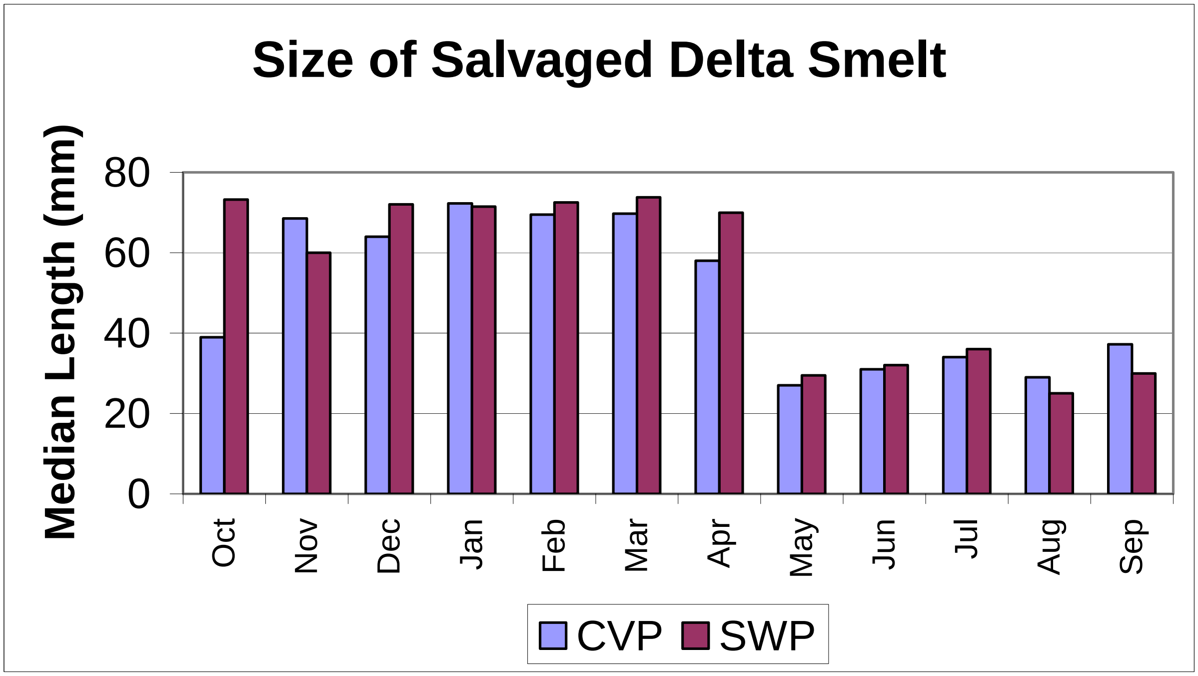
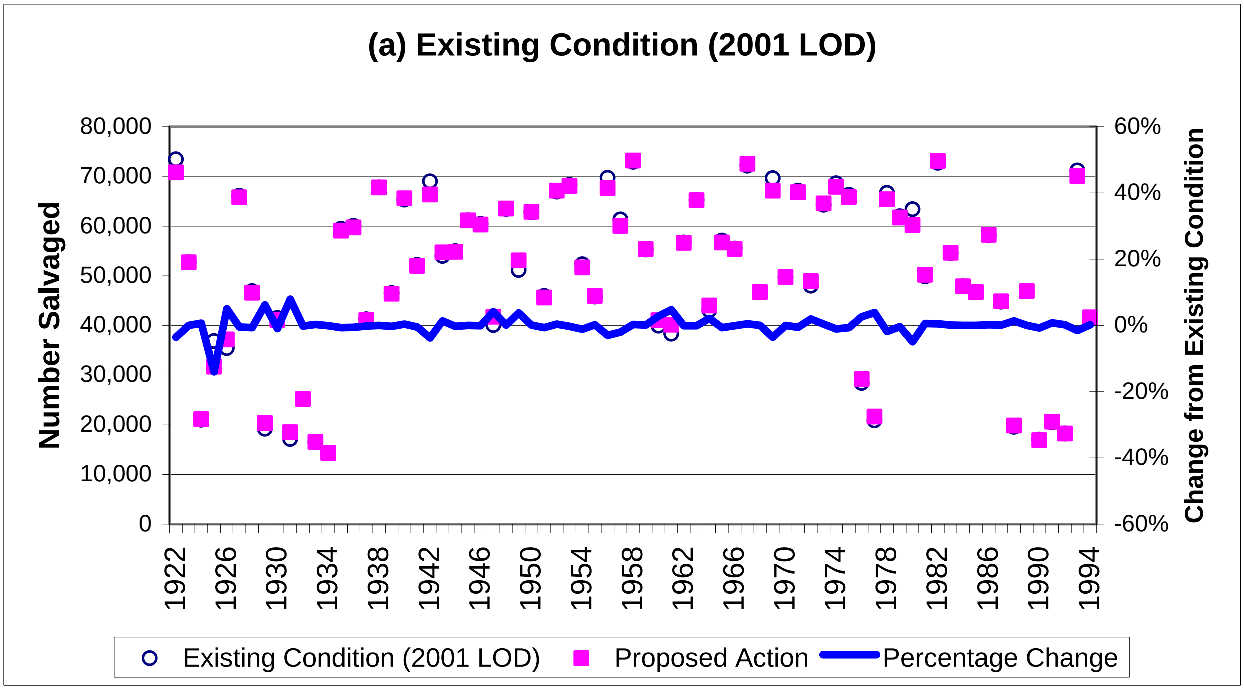


Figure 3.5-25. Simulated Salvage for Splittail under the Proposed Action Relative to (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



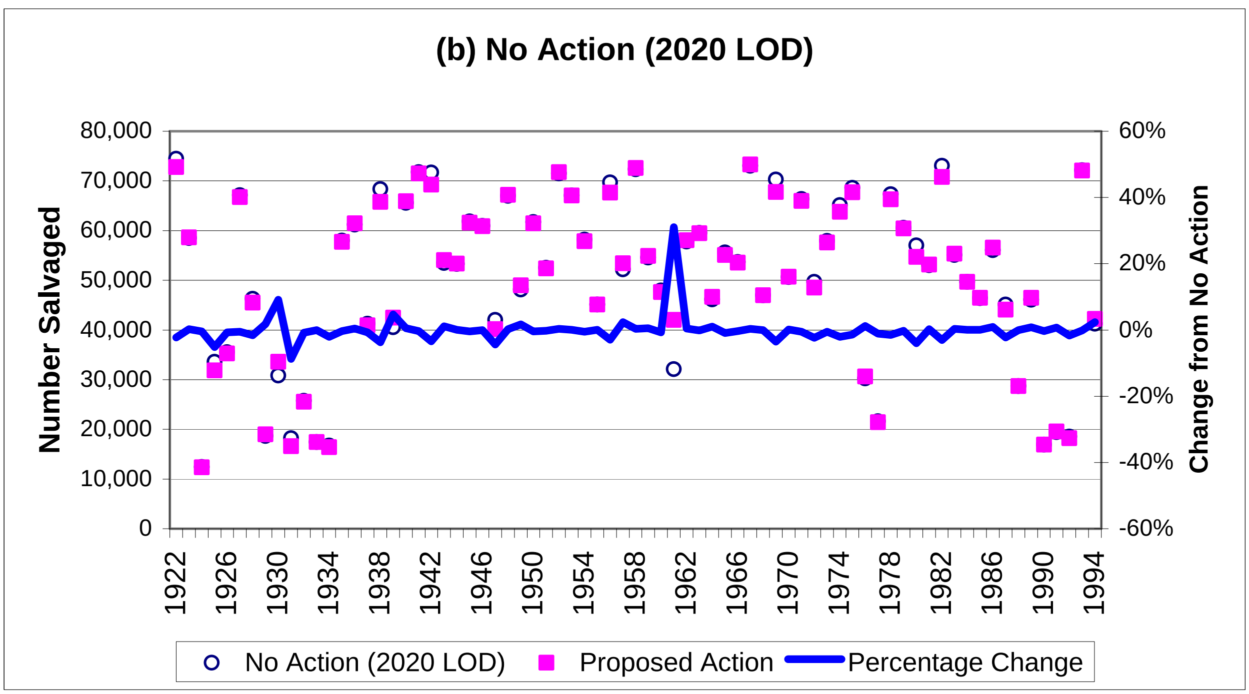


Figure 3.5-26. Monthly Median Size of Splittail Salvaged at the SWP and CVP Fish Facilities, 1980–2002 Historical Data

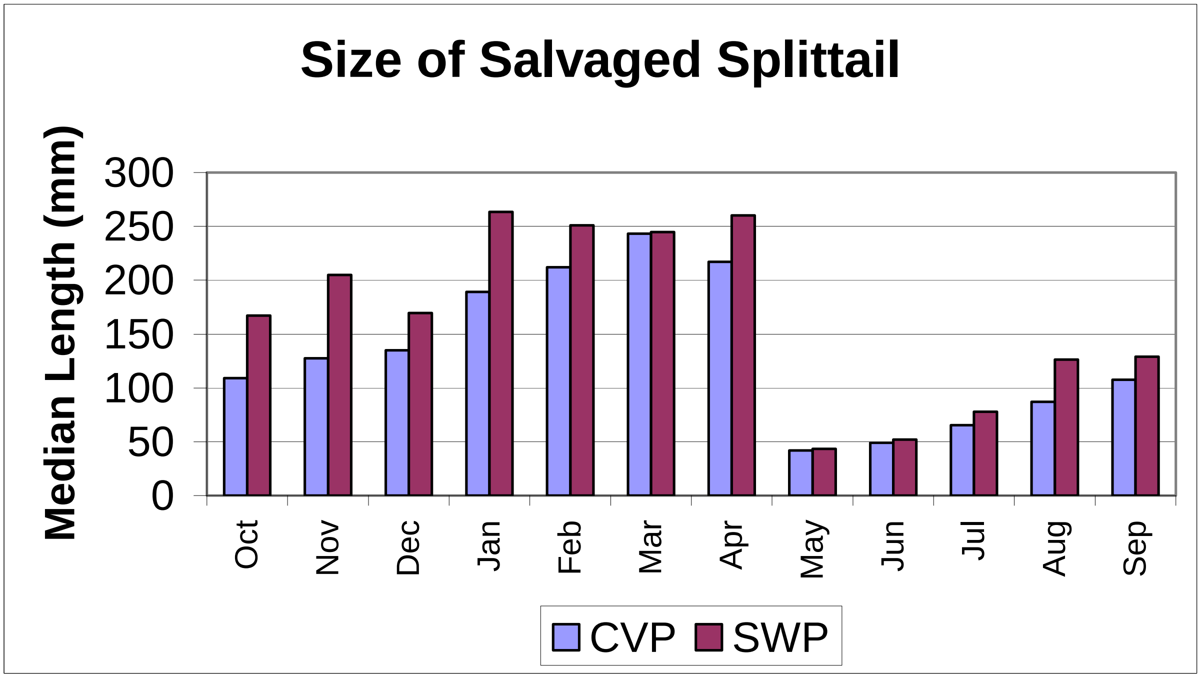
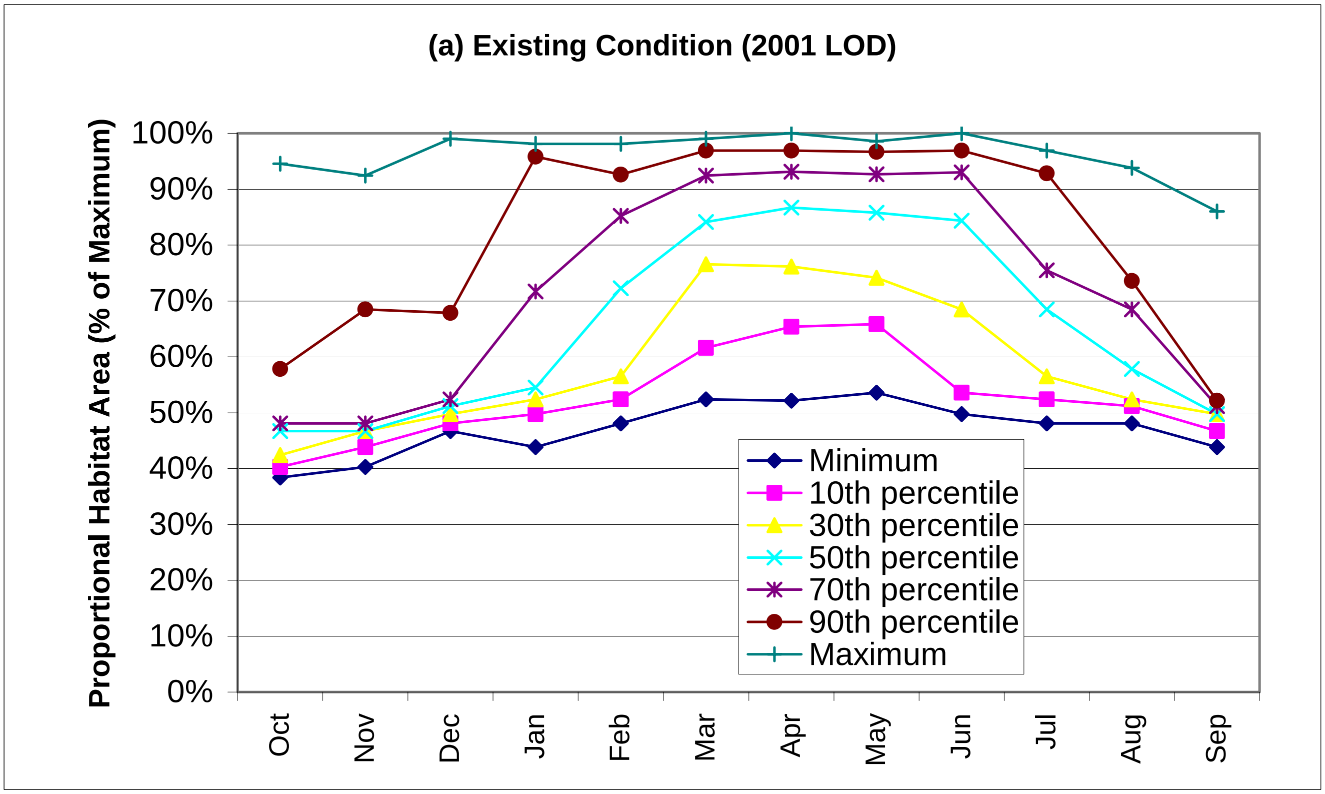


Figure 3.5-27. Occurrence of Proportional Estuarine Rearing Habitat Area for Striped Bass under (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



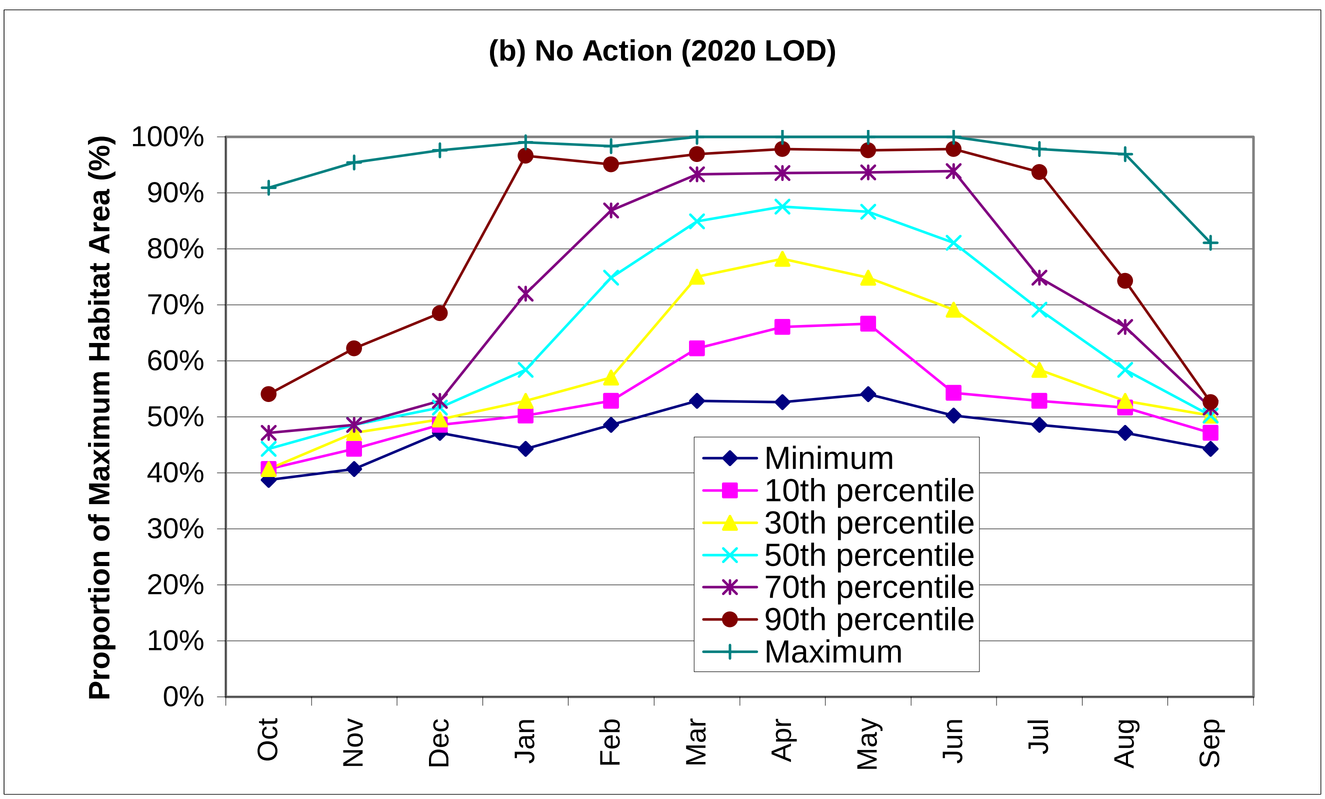
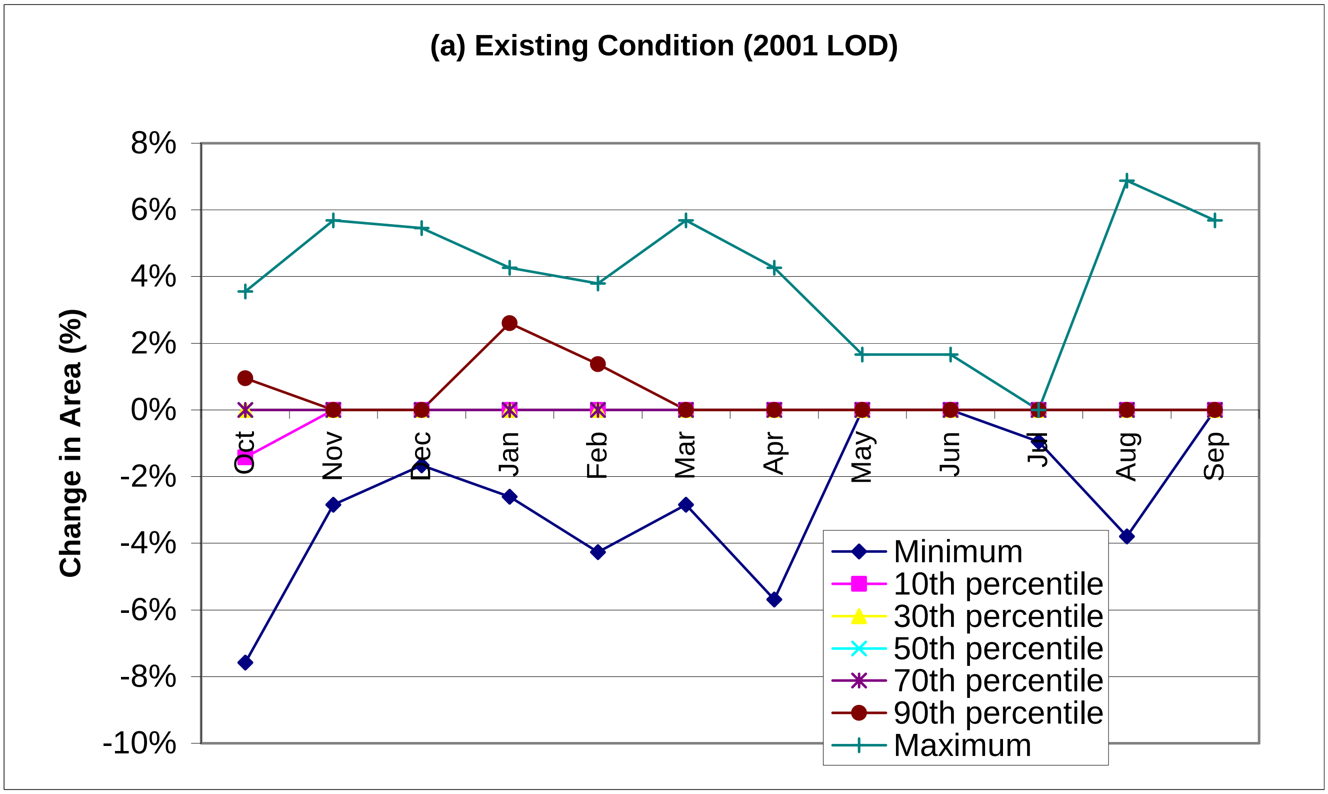


Figure 3.5-28. Change in the Proportion of Estuarine Rearing Habitat Area for Striped Bass under the Proposed Action Relative to (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation



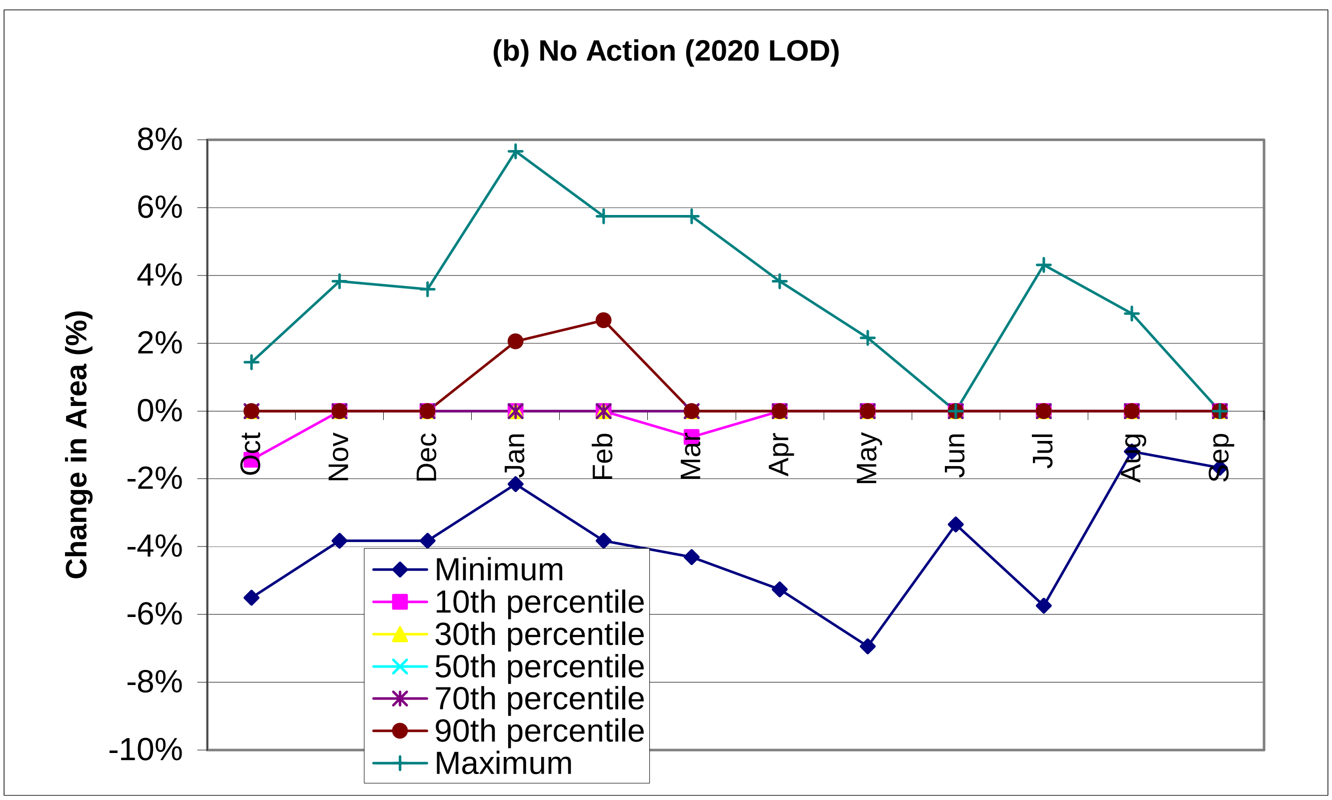


Figure 3.5-29. Simulated Salvage for Striped Bass under the Proposed Action Relative to (a) Existing Condition (2001 LOD) and (b) No Action (2020 LOD), 1922–1994 Simulation